Dr. Mahalingam College of Engineering and Technology

(An Autonomous Institution)

Pollachi - 642 003

Curriculum and Syllabi

B.E. MECHANICAL ENGINEERING

Semesters I to VIII

REGULATIONS 2019

Programme: B.E. Mechanical Engineering
Curriculum and Syllabi: Semesters – I to VIII
Recommended by Board of Studies on
Approved by Academic Council on

Action	**Responsibility**	**Signature of Authorized Signatory**
Prepared by	BoS Mechanical Engineering	
Compiled and Verified by	Office of the Controller of Examinations	
	Office of Academic Coordination Team	
Approved by	Principal	

Department of Mechanical Engineering

Vision

To transform students from background into professional leaders of tomorrow in the field of mechanical engineering with strong sense of social commitment

Mission:

- To impart quality –engineering education leading to specialization in the emerging areas of CAD/CAM/CAE, Energy Engineering and Materials Technology.
- To provide continually updated and intellectually stimulating environment to pursue research and consultancy activities.

Programme: B.E. Mechanical Engineering

Programme Educational Objectives (PEOs) - Regulation 2019

B.E. Mechanical Engineering graduates will:

PEO1.Technical Expertise: Actively apply technical and professional skills in engineering practices towards the progress of the organization or the entrepreneurial venture in competitive and dynamic environment.

PEO2.Lifelong Learning: Own their professional and personal development by continuous learning and apply the learning at work to create new knowledge.

PEO3.Ethical Knowledge: Conduct themselves in a responsible, professional and ethical manner supporting sustainable economic development which enhances the quality of life.

Programme Outcomes (POs) - Regulations 2019

On successful completion of B.E. Mechanical Engineering programme, graduating students/graduates will be able to:

PO1. Apply knowledge of basic sciences and engineering concepts to solve complex mechanical engineering problems.

PO2. Identify, formulate, and analyze engineering problems using scientific principles and concepts.

PO3. Design products, manufacturing processes and facilities that deliver the requirements of the target customers and desired quality functions.

PO4. Conduct experiments, analyze and interpret data to provide solutions for engineering problems.

PO5. Use appropriate tools and techniques to solve engineering problems.

PO6. Apply contextual knowledge to make informed decisions in societal, health, safety, legal, entrepreneurial and cultural issues.

PO7. Demonstrate the knowledge of need for sustainable development in providing engineering solutions in global, environmental and societal contexts.

PO8. Practice Ethical responsibility.

PO9. Work effectively in teams and build/manage interpersonal relationships.

PO10. Communicate effectively through oral, non-verbal and written means.

PO11. Apply management principles to manage individual and team work for executing projects in a multidisciplinary environment.

PO12. Articulate and engage in pursuit of career and life goals through continuous Learning.

Programme Specific Outcomes (PSOs) - Regulations 2019

On successful completion of B.E. Mechanical Engineering programme, graduating students/graduates will be able to:

PSO 1: Demonstrate functional competencies for roles in design, manufacturing and service by learning through centers of excellence and industrial exposure.

PSO 2: Demonstrate behavioral competencies required for roles in design, manufacturing and service by learning through structured professional skills training.

Programme : Mechanical Engineering
2019 Regulations(2021 batch onwards)
Curriculum for Semesters I to VIII

Course Code	Course Title	Duration	Credits	Marks
19SHMG6101	Induction Program	3 Weeks	-	-

Semester I

Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
19MABC1101	Matrices and Calculus	3	1	0	4	100	AU, CE, MC, ME, EC, EI, EE
19ENHG2101	Communication Skills - I	2	0	2	3	100	All
19PHBC2101	Physics for Mechanical Sciences	3	0	2	4	100	AU, ME, MC
19CSSC2001	C Programming	3	0	2	4	100	AU, CE, MC, ME,EC, EI, EE
19MESC4001	Engineering Drawing	1	0	3	2.5	100	AU, ME, MC, CS, IT, EC, EI,SC,AM,AD
19PSHG6001	Wellness for Students	0	0	2	1	100	All
Total		**12**	**1**	**11**	**17.5**	**600**	

Semester II

Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
19MABC1201	Ordinary Differential equations and Complex Variables	3	1	0	4	100	AU, CE, MC, ME, PR, EC, EI, EE
19ENHG2201	Communication Skills – II	2	0	2	3	100	All
19CHBC2201	Chemistry for Mechanical Sciences	3	0	2	4	100	AU, CE, ME, MC, PR, EE
19MESC2001	Introduction to Engineering	2	0	2	3	100	AU, MC, ME, PR, EC, EI, EE
19MESC2201	Engineering Materials	2	0	2	3	100	AU, MC, ME,PR
19MECC3201	Engineering Practices Laboratory	0	0	3	1.5	100	AU, ME, MC, PR
19CHMG6201	Environmental Sciences	1	0	0	-	-	All
19PSHG6003	தமிழர்மரபு /Heritage of Tamils**	1	0	0	1	100	All
TOTAL		**13**	**1**	**13**	**20.5**	**700**	

** Applicable only for 2022 Batch

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABC1301	Numerical Methods	3	1	0	4	100	AU, ME
19MESC1301	Engineering Mechanics	3	1	0	4	100	AU, ME, MC
19MECC2301	Fluid Mechanics and Hydraulic Machinery	3	0	2	4	100	AU, ME, MC
19MECN2301	Metrology and Measurement	3	0	2	4	100	-
19MECN1301	Manufacturing Processes	3	0	0	3	100	-
19MECN3301	Computer Aided Modeling and Drafting Laboratory	0	0	3	1.5	100	-
19MECN3302	Manufacturing Processes Laboratory	0	0	3	1.5	100	-
XXXXXXXXXX	One Credit Course	0	0	2	1	100	-
19PSHG6004	தமிழரும்தொழில்நுட்பமும் / Tamils and Technology**	2	0	0	1	100	All
Total		**15**	**2**	**12**	**24**	**800**	

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABG1401	Probability and Statistics	3	1	0	4	100	AU, ME, CS, IT, EC, EE,CE
19MECC2401	Strength of Materials	3	0	2	4	100	AU, ME, MC
19MECN2401	Theory of Machines	2	1	2	4	100	-
19MECN1401	Manufacturing Technology	3	0	0	3	100	-
19MECN3401	Manufacturing Technology Laboratory	0	0	3	1.5	100	-
19PSHG6002	Universal Human Values 2: Understanding Harmony	2	1	0	3	100	All
19MEPN6401	Mini–Project	0	0	4	2	100	
XXXXXXXXXX	One Credit Course	0	0	2	1	100	-
Total		**13**	**3**	**9**	**22.5**	**700**	

Course Code	Course Title	Duration	Credits	Marks
19MEPN6001	Internship or Skill Development*	2/4 Weeks	1	100

*Refer to clause:4.8 in UG academic regulations 2019
** Applicable only for 2022 Batch

Semester V

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MECC1501	Mechanical Design	3	1	0	4	100	MC,ME
19MECN2501	Applied Thermodynamics	3	0	2	4	100	-
19MECN2502	Electrical and Electronics Engineering	3	0	2	4	100	-
19MECC2501	Problem solving using PYTHON for Mechanical Sciences	2	0	2	3	100	AU, MC, ME
19MEEXXXXX	Professional Elective -I	3	0	0	3	100	-
19MEEXXXXX	Professional Elective –II (Online)	3	0	0	3	100	-
19MEOCXXXX	Open Elective - I	3	0	0	3	100	-
19MECN3501	Computer Aided Machine Drawing Laboratory	0	0	3	1.5	100	-
19PSHG6501	Employability Skills 1 : Teamness and Interpersonal Skills	0	0	2	1	100	All
Total		**20**	**1**	**11**	**26.5**	**900**	

Semester VI

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MECC1601	Finite Element Analysis	3	1	0	4	100	AU, ME
19MECN2601	Heat and Mass Transfer	2	1	2	4	100	-
19MECC1602	Data Science for Engineers	3	0	0	3	100	AU, MC, ME
19MEEXXXXX	Professional Elective -III	3	0	0	3	100	-
19MEEXXXXX	Professional Elective –IV (Online)	3	0	0	3	100	-
19MEOCXXXX	Open Elective -II	3	0	0	3	100	-
19PSHG6601	Employability Skills 2 : Campus to Corporate	0	0	2	1	100	All
19MEPN6601	Innovative and Creative Project	0	0	4	2	100	-
Total		**18**	**1**	**8**	**23**	**800**	

Course Code	Course Title	Duration	Credits	Marks
19MEPN6002	Internship or Skill Development*	2/4 Weeks	1	100

*Refer to clause: 4.8 in UG academic regulations 2019

Semester VII

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MECN1701	Mechatronics	3	0	0	3	100	-
19MECC1701	Artificial Intelligence and Machine Learning	3	0	0	3	100	AU, ME
19MECN2701	CNC Machines and Robotics	3	0	2	4	100	-
19MEEXXXXX	Professional Elective – V	3	0	0	3	100	-
19MEEXXXXX	Professional Elective – VI	3	0	0	3	100	-
19MEOCXXXX	Open Elective - III	3	0	0	3	100	-
19MECC3701	Simulation and Analysis Laboratory	0	0	3	1.5	100	-
19MECN3701	Mechatronics Laboratory	0	0	3	1.5	100	-
Total		**21**	**0**	**8**	**22**	**800**	

Semester VIII

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19SHVG6001/ 19SHVG6002	Entrepreneurship Development/ தமிழர்மரபும் பண் பொடும்/ Culture and Heritage of Tamils	1	0	0	1	100	All
19MEPN6801	Project	0	0	16	8	200	-
Total		**1**	**0**	**16**	**9**	**300**	-

Course Code	Course Title	Duration	Credits	Marks
19MEPN6003	Internship or Skill Development*	8 /16 weeks	4	100

*Refer to clause: 4.8 in UG academic regulations 2019

Total Credits: 169

Course Code	Course Title	Hours / Week			Credits	Marks	Common to Programmes
		L	T	P			
VERTICAL I DESIGN ELECTIVES							
19MEEN1023	Rapid Prototyping and Tooling	3	0	0	3	100	-
19MEEN1001	Mechanical System Design	3	0	0	3	100	-
19MEEN1024	Design for X	3	0	0	3	100	-
19MEEC1007	Design for Sheet Metal	3	0	0	3	100	AU & ME
19MEEN1004	Design for Welding	3	0	0	3	100	-
19MEEN1025	Design thinking	3	0	0	3	100	-
19MEEN1026	Reverse Engineering	3	0	0	3	100	-
19MEEC1005	Design of Transmission Systems	3	0	0	3	100	MC & ME
19MEEN1008	Nano materials synthesis and characterization	3	0	0	3	100	-
VERTICAL II MANUFACTURING ELECTIVES							
19MEEC1009	Additive Manufacturing	3	0	0	3	100	AU, MC & ME
19MEEN1005	Process Planning and Cost Estimation	3	0	0	3	100	-
19MEEN1006	Advanced Manufacturing Processes	3	0	0	3	100	-
19MEEC1012	Lean Manufacturing	3	0	0	3	100	AU & ME
19MEEN1010	Manufacturing Systems Engineering	3	0	0	3	100	-
19MEEN1027	Sustainable Manufacturing	3	0	0	3	100	-
19MEEC1014	Engineering Economics and Cost Analysis	3	0	0	3	100	AU & ME
19MEEC1008	Composite Materials	3	0	0	3	100	AU, MC & ME
VERTICAL III ENERGY ELECTIVES							
19MEEN1028	Energy conservation in industry	3	0	0	3	100	-
19MEEN1013	Power Plant Engineering	3	0	0	3	100	-
19MEEN1029	Gas Dynamics and Space Propulsion	3	0	0	3	100	-
19MEEN1030	Computational Techniques for Fluid Dynamics	3	0	0	3	100	-
19MEEN1031	Energy Storage Devices	3	0	0	3	100	-
19MEEN1015	Solar and Wind Energy Engineering	3	0	0	3	100	-
19MEEN1032	Alternative Fuels And Energy Systems	3	0	0	3	100	-
19MEEN1014	Refrigeration and Air-Conditioning	3	0	0	3	100	-

Course Code	Course Title	Hours /Week			Credits	Marks	Common to Programmes
		L	T	P			
VERTICAL IV QUALITY ELECTIVES							
19MEEC1011	Non Destructive Testing Methods	3	0	0	3	100	AU, MC & ME
19MEEN1033	Geometric Dimensioning & Tolerancing for Mechanical Design	3	0	0	3	100	-
19MEEN1011	Operations Research	3	0	0	3	100	-
19MEEN1012	Total Productive Maintenance	3	0	0	3	100	-
19MEEC1016	Quality Engineering	3	0	0	3	100	AU, MC & ME
19MEEN1034	Lean Six sigma	3	0	0	3	100	
19MEEC1002	Design for Manufacture, Assembly and Environment	3	0	0	3	100	AU, MC & ME
19MEEC1015	Principles of Management	3	0	0	3	100	MC & ME
19MEEC1017	Industrial Safety Management	3	0	0	3	100	AU, MC & ME
VERTICAL V E-MOBILITY ELECTIVES							
19MEEN1003	Motor Cycle Dynamics	3	0	0	3	100	-
19MEEN1035	Electric Vehicle Design	3	0	0	3	100	-
19EEEC1049	Advanced Sensors for Electric Vehicle	3	0	0	3	100	EEE & ME
19EEEC1050	Testing and Certification of Electric Vehicle	3	0	0	3	100	EEE & ME
19AUEC1006	Electric Vehicle Architecture	3	0	0	3	100	-
19MEEN1037	Electric Vehicle Thermal Engineering	3	0	0	3	100	-
19MEEN1016	Battery system for Electric vehicle	3	0	0	3	100	-
19AUEC1005	Electric vehicle Powertrains	3	0	0	3	100	AU & ME
19AUEC1007	Electric Vehicle Charging System	3	0	0	3	100	AU & ME
VERTICAL VI AUTOMATION ELECTIVES							
19MEEC1019	Industrial IoT	3	0	0	3	100	AU, MC & ME
19EEEC1053	Industry 4.0 – Smart Factories	3	0	0	3	100	EEE & ME
19MEEN1020	Fluid power system	3	0	0	3	100	-

19MEEN1017	Embedded system for automobiles	3	0	0	3	100	-
19MEEC1010	Flexible Manufacturing Systems	3	0	0	3	100	MC & ME
19MEEN1022	Advanced Computer Integrated Manufacturing	3	0	0	3	100	-
19MEEN1038	Sensors and Instrumentation	3	0	0	3	100	-
19MEEC1013	Logistics Engineering	3	0	0	3	100	AU & ME
DIVERSIFIED COURSES I ELECTIVES							
19MEEC1001	Product Life Cycle Management	3	0	0	3	100	AU, MC & ME
19MEEC1023	Model based Systems Engineering	3	0	0	3	100	AU, MC & ME
19MEEC1024	New Product Development	3	0	0	3	100	AU, MC & ME
19MEEC1018	Automobile Engineering	3	0	0	3	100	MC & ME
19MEEC1003	Vibration and Noise Engineering	3	0	0	3	100	MC & ME
19MEEC1021	Java Programming for Mechanical Sciences	3	0	0	3	100	AU& ME
19SCEC2001	Cyber Security	3	0	0	3	100	All
19MEEC1022	Data Structures and Object Oriented Programming with C++	3	0	0	3	100	AU& ME
19MEEC1006	Automotive Engine and Its Systems	3	0	0	3	100	MC & ME
19MEEC2001	Mechanical Engineering Design and Automation	2	0	2	3	100	AU , ME& CE
19MEEC2002	PLM for Engineers	2	0	2	3	100	ALL
19AUEC1006	Electronic Steering System	3	0	0	3	100	AU& ME

OPEN ELECTIVES

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19MEOC1001	Automation systems	3	0	0	3	100
19MEOC1002	Entrepreneurship Development	3	0	0	3	100
19MEOC1003	Telematics for Transport	3	0	0	3	100
19MEOC1004	Industrial Automation and Robotics	3	0	0	3	100
19MEOC1005	Vehicular Communication Electronics	3	0	0	3	100
19MEOC1006	Total Quality Management	3	0	0	3	100
19MEOC1007	Industrial Safety Engineering	3	0	0	3	100
19MEOC1008	Industrial Engineering	3	0	0	3	100
19MEOC1009	Renewable Sources of Energy	3	0	0	3	100

Course Code: 19SHMG6101	Course Title: INDUCTION PROGRAM (common to all B.E/B.Tech programmes)
Course Category: Mandatory Non-Credit Course	**Course Level: Introductory**
Duration: 3 Weeks	**Max. Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain various sources available to meet the needs of self, such as personal items and learning resources.
2. Explain various career opportunities, opportunity for growth of self and avenues available in the campus.
3. Explain the opportunity available for professional development.
4. Build universal human values and bonding amongst all the inmates of the campus and society.

List of Activities:

1. History of Institution and Management: Overview on NIA Education Institutions-Growth of MCET – Examination Process-OBE Practices – Code of Conduct – Centre of Excellence
2. Lectures by Eminent People, Motivational Talk – Alumni, Employer
3. Familiarization to Dept./Branch: HoD Interaction – Senior Interaction – Department Association
4. Universal Human Value Modules: Module 1, Module 2,Module 3 and Module 4
5. Orientation on Professional Skill Courses
6. Proficiency Modules – Mathematics, English, Physics and Chemistry
7. Introduction to various Chapters, Cell, Clubs and its events
8. Creative Arts: Painting, Music and Dance
9. Physical Activity: Games and Sports, Yoga and Gardening
10. Group Visits: Visit to Local areas and Campus Tour

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Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain various sources available to meet the needs of self, such as personal items and learning resources through visit to local areas and campus	Understand
CO2: Explain various career opportunities and avenues available in the campus through orientation sessions	Understand
CO3: Explain the opportunity available for professional development through professional skills, curricular, co-curricular and extracurricular activities	Understand
CO4: Build universal human values and bonding amongst all the inmates of the campus and society for having a better life	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO2	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO3	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO4	2	-	-	-	-	-	-	2	1	2	-	-	-	-

High-3; Medium-2;Low-1

Assessment Pattern

Component	Marks	Details
Attendance	10	Minimum 80% and 1 mark for every 2% observed
Knowledge Test	40	Objective type questions
Work plan for future	50	Career plan developed consulting mentor
Total	**100**	

Non-letter Grades

Marks Scored	Performance Level
70 & above	Good
30 – 69	Average
< 30	Fair

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<table>
<tr><td>Course Code: 19MABC1101</td><td colspan="3">Course Title: MATRICES AND CALCULUS
(Common to AU, CE, MC, ME, EC, EI & EE)</td></tr>
<tr><td colspan="2">Course Category: Basic Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 1: 0</td><td>Credits:4</td><td>Total Contact Hours:60</td><td>Max. Marks:100</td></tr>
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Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Determine the canonical form of a Quadratic form using Orthogonal transformation.
2. Use different testing methods to check the convergence of infinite series.
3. Apply differential and integral calculus to determine the evolute of a curve and improper integrals.
4. Apply partial derivatives to find extreme values of functions of two variables.
5. Apply multiple integrals to find area of plane curves and volume of solids.

UNIT I Matrices 9+3

Rank of a matrix, System of linear equations, Symmetric, Skew symmetric and orthogonal matrices-(Definitions and examples only), Eigenvalues and Eigenvectors, Diagonalization of symmetric matrices through orthogonal transformation, Cayley-Hamilton Theorem, Transformation of quadratic forms to canonical forms through orthogonal transformation.

UNIT II Sequences And Series 9+3

Sequences- Definition and Examples, Series- Tests for convergence- Power series-series for exponential, trigonometric and logarithm functions - Comparison Test, IntegralTest, Cauchy's root test, D Alembert's ratio test, Alternating series- Leibnitz's test.

UNIT III Differential And Integral Calculus 9+3

Curvature – Radius of curvature - Evolutes and Involutes, Evaluation of definite and improper integrals, Beta and Gamma functions and their properties.

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UNIT IV Multivariable Differentiation 9+3

Limit, continuity, Mean value theorems and partial derivatives, Taylor's series and Maclaurin's series, Jacobian, Maxima, Minima and saddle points, Method of Lagrange's multipliers.

UNIT V Multivariable Integration 9+3

Multiple Integration: Double integrals (Cartesian), Change of order of integration in double integrals, Change of variables (cartesian to polar and cartesian to spherical), Triple integrals (Cartesian) Applications: areas and volumes.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Determine the canonical form of a Quadratic form using Orthogonal transformation	Apply
CO2: Use different testing methods to check the convergence of infinite series.	Apply
CO3: Determine the evolute of a curve and evaluate improper integrals using beta gamma functions	Apply
CO4: Apply partial derivatives to find extreme values of functions of two variables .	Apply
CO5: Apply multiple integrals to find area of plane curves and volume of solids	Apply

Text Book(s):

T1. Erwin kreyzig, "Advanced Engineering Mathematics", 10th edition, John Wiley & Sons, 2015.

T2. Veerarajan T., "Engineering Mathematics for First Year" , Tata McGraw-Hill, New Delhi, 2011.

T3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 1st edition, 2017.

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9th edition, Pearson, Reprint, 2010.

R2. N.P.Bali and Manish Goyel, "A Text book of Engineering Mathematics", Laxmi Publication, 9th edition, 2010.

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R3. B.S.Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 43rd Edition, 2014.

Web References:

1. **https://onlinecourses.nptel.ac.in/noc16_ma05**
2. **https://nptel.ac.in/courses/122101003/2**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	1	1	-	1	-	1	-	-

High-3; Medium-2;Low-1

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Course Code: 19ENHG2101	Course Title: COMMUNICATION SKILLS – I (Common to all B.E/B.Tech Programmes)		
Course Category: Humanities		Course Level: Practice	
L:T:P (Hours/Week) 2: 0: 2	Credits:3	Total Contact Hours:60	Max. Marks:100

Pre-requisites:

- The student should have undergone English as his/her first or second language in school.

Course Objectives:

The course is intended to:

1. Listen and understand monologues and dialogues of a native speaker on par with B1 of CEFR level.
2. Speak in simple sentences to convey their opinion and ideas on par with B1 of CEFR level.
3. Read and infer a given text on par with B1 of CEFR level.
4. Draft basic formal written communication on par with B1 of CEFR level.

UNIT I Listening 15

Importance of active listening –Physical condition needed for active listening-Identifying relevant points while taking notes.- Framing questions at different linguistic contexts - Listening for specific details of concrete monologues and dialogues –Listening to organize ideas - Developing ideas –Listening to compose paragraphs – Paraphrasing the aural input.

UNIT II Speaking 15

Importance of note making to practice speaking - Traditional note making, developing Mind map - Collecting points from various sources - Identifying relevant ideas needed for the speech -Using mind-map to organize thought processing - Prioritizing the ideas - Types of sentences - Frequently used words (Institution, home and leisure) - Mother Tongue Influence - Expressing the thoughts in simple sentences - Tenses & Voices (Active & Passive) - Postures, gestures and eye contact - Intonation and Sentence stress - Express one's thoughts coherently.

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UNIT III Reading **15**

Reading strategies - Skimming -Scanning - Interpretation of visual data - Factual texts on subjects of relevance - Inferring texts –Reading to write a review –Checking the accuracy of reading while presenting the interpreted data – Reading to comprehend

UNIT IV Writing **15**

WritingSimple and short sentences **-** Writing E-mail, Memo, Note and Message - Letter Writing - Importance of punctuations -- Identifying the main points - Organising the main ideas - Writing a draft.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Listen actively and paraphrase simple messages and specific details of concrete monologues and dialogues.	Apply
CO2: Express one's views coherently in a simple manner.	Apply
CO3: Read and comprehend factual texts on subjects of relevance.	Understand
CO4: Write texts bearing direct meanings for different contexts maintaining an appropriate style.	Apply

Text Book(s):

T1. Whitby Norman, Business Benchmark Pre-intermediate to Intermediate Students' Book CUP Publications, 2nd Edition, 2014

T2. Wood Ian, Williams Anne, Cowper Anna, Pass Cambridge BEC Preliminary, Cengage Learning, 2nd Edition, 2015.

T3. Learners Book prepared by the Faculty members of Department of English.

Reference Book(s):

R1. BEC-Preliminary - Cambridge Handbook for Language Teachers, 2nd Edition, CUP 2000.

R2. Hewings Martin - Advanced Grammar in use - Upper-intermediate Proficiency, CUP, 3rd Edition, 2013

Web References:

1. http://www.grammarinenglish.com
2. https://www.northshore.edu/support_centre /pdf/listen-notes.pdf
3. http://www.examenglish.com/BEC/BEC_Vantage.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	1	1	2	1	3	-	1	-	1
CO2	-	-	-	-	-	1	1	2	1	3	-	1	-	1
CO3	-	-	-	-	-	1	1	2	1	3	-	1	-	1
CO4	-	-	-	-	-	1	1	2	1	3	-	1	-	1

High-3; Medium-2;Low-1

<table>
<tr><td>Course Code: 19PHBC2101</td><td colspan="3">Course Title: PHYSICS FOR MECHANICAL SCIENCES
(Common to AU, ME, MC)</td></tr>
<tr><td colspan="2">Course Category: Basic Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week) 3: 0: 2</td><td>Credits:4</td><td>Total Contact Hours:75</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Determine the equilibrium condition of particles and rigid bodies.
2. Understand the motion of a particle.
3. Study the properties of acoustics and their applications.
4. Extend the knowledge of thermal properties to their applications.
5. Understand the basic principles of thermodynamics.

UNIT I Basics of Mechanics 9

Review of fundamental laws of mechanics – Physical quantities – scalars, vectors – Newton's law of mechanics, Gravitational law. Particles and rigid body, Concept of force and its effect on rigid body system of forces-Free body diagram-principle of transmissibility-equilibrium conditions-equilibrium of particles subjected to coplanar and non-coplanar force system – equilibrium of particles subjected to coplanar system of forces - Triangle law, Parallelogram law and Lami's theorem.

UNIT II Kinematics and Kinetics of Particles 9

Kinematic parameters – displacement, velocity, acceleration and time. Types of motion – uniform, non-uniform motion, motion of particles in a plane – Rectinlear and curvilinear motion of particles – normal and tangential component – motion of projectile – Relative motion – Dependent motion. Kinetics of particles – Force and acceleration - D'Alembert's principle – Work energy, and impulse momentum method.

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UNIT III Physics of Sound 9

Classification of sound - decibel- Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption Coefficient and its determination – factors affecting acoustics of buildings and their remedies. Methods of sound absorptions: absorbing materials, paints - noise and its measurements, sound insulation and its measurements, impact of noise in machineries.

UNIT IV Thermal Physics 9

Thermal conductivity, Specific heat capacity, Thermal shock resistance, Thermal stability, Thermal Expansion, Thermal insulation and Heat resistance.

Conduction – Co-efficient of the thermal conductivity – Cylindrical flow of heat – determination of thermal conductivity of bad conductor – Lee's disc method: theory and experiment – Conduction through compound media (series and parallel)

UNIT V Elements of Thermodynamics 9

Concept of temperature – heat – thermodynamics – work – heat in thermodynamics – comparison of heat and work – internal energy – first law of thermodynamics – applications of the first law– second law of thermodynamics – the Carnot cycle – heat engine – heat pump – refrigerators – third law of thermodynamics.

LIST OF EXPERIMENTS 30

1. Determination of Thermal Conductivity of the insulator – Lee's Disc.
2. Determination of velocity and compressibility of the given liquid – Ultrasonic Interferometer.
3. Determination of Young's modulus – Cantilever bending.
4. Determination of Rigidity modulus of the metallic wire – Torsional Pendulum.
5. Determination of Wavelength of laser and determination of particle size using laser.
6. Verify the triangular law of forces – Lami's theorem.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Use the laws of mechanics to determine the equilibrium condition of particles and rigid bodies.	Understand
CO2: Explain the motion of a particle.	Understand
CO3: Explain the properties of acoustics and their applications.	Understand
CO4: Explain the thermal properties of materials.	Understand
CO5: Explain the principles of thermodynamics.	Understand

Text Book(s):

T1. R. C. Hibbeller, “Engineering Mechanics: Combined Static and Dynamics”, Prentice Hall, 2010.

T2. V. Rajendran, “Engineering Physics”, Tata McGraw Hill Publishing Company limited. New Delhi, 2017.

T3. M.N.Avadhanulu and P.G.Kshirsagar, “Text Book of Engineering Physics”, S. Chand & Company Ltd., New Delhi, 2018.

Reference Book(s):

1. Balasubramaniam "Callister's Material Science and Engineering", John Wiley and Sons Inc., Second Edition, 2015.
2. Brijlal & N. Subramaniam, “Heat & Thermodynamics”, S.Chand & Co., 2008.
3. A.Marikani, “Engineering Physics”, PHI Learning Pvt. Ltd., 2013.

Web References:

1. http://www.physicsclassroom.com/class/thermal
2. http://nptel.ac.in/course.php?disciplineId=115

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	1	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	1	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	1	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	1	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	1	1	-	1	-	1	-	-

High-3; Medium-2;Low-1

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Course Code: 19CSSC2001	Course Title: C PROGRAMMING (Common to AU, CE, MC, ME, EC, EI, EE)		
Course Category: Engineering Science		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours:75	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Explain about computer organization and problem solving techniques.
2. Write programs using appropriate programming constructs.
3. Develop programs using arrays, functions & strings.
4. Implement programs using pointers, structures & unions.
5. Write programs using files & preprocessor directives.

UNIT I Introduction 7

Generation and Classification of Computers –Basic Organization of a Computer – Software development life cycle – Problem Solving Techniques , Algorithm, Pseudo code and Flow Chart.

UNIT II C Programming Basics 10

Introduction to C programming – Structure of a C program – Keywords – Identifiers-Constants–Variables –Data Types– Operators and Expressions –Formatted & Unformatted I/O functions–Decision statements –Loop control statements.

UNIT III Arrays, Functions & Strings 10

Arrays: Characteristics –One-dimensional and Two-dimensional arrays – Functions: Declaration & Definition of function –Built in function – User defined function –Types of functions –Call by value &reference– Strings: Formatting strings–String handling functions.

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UNIT IV Pointers, Structures & Union **9**

Pointers: Features and Types of pointers – Arithmetic operations with pointers–Pointers and Arrays –Structures: Features– Operations on Structures–Array of structures – Unions.

UNIT V Files & Pre-Processor Directives **9**

Introduction to Files –Stream and File Types–File operations (Open, close, read, write) – Command line arguments–Pre-processor Directives: Macro Expansion, File Inclusion, Conditional Compilation.

LIST OF EXPERIMENTS **30**

1. Programs to process data types, operators and expression evaluation (any1).
   a. To find area of rectangle/circle/square.
   b. To find the simple interest and compound interest.
2. Programs using decision and looping statements(any 2).
   a. To find the maximum number among 3 given numbers.
   b. To check whether given year is leap year or not.
   c. To display the Fibonacci series.
   d. To find the factorial of a number.
3. Programs using Arrays.
   a. To search for particular number among N numbers(1D array).
   b. To compute matrix addition (2 D array).
4. Programs using Functions and Strings(any 2).
   a. To swap two numbers using call by reference.
   b. To find the cube of a number.
   c. To manipulate strings using string functions.
   d. To check whether the string is palindrome or not.
5. Programs using Pointer, Structure & Union
   a. To perform arithmetic operations using pointers.
   b. To display the information of N students using Structure.
   c. To display the employee details using Union.
6. Programs using Files (any 1)
   a. To read the contents of a text file
   b. To copy the contents from one file into another

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain about computer organization and problem solving techniques	Understand
CO2: Write programs for the given scenario using appropriate programming constructs	Apply
CO3: Develop programs using arrays, functions & strings for the given scenario	Apply
CO4: Implement programs for given application using pointers, structures & unions	Apply
CO5: Write programs using files & preprocessor directives for simple problems	Apply

Text Book(s):

T1. Ashok N.Kamthane, Amit.N.Kamthane, “Programming in C”, 3^{rd} Edition, Pearson Education, 2015.

Reference Book(s):

R1. Ajay Mittal, “Programming in C-A Practical Approach”, 3^{rd} Edition, Pearson Education, 2010.

R2. Yashavant P.Kanetkar, “Let Us C”, 16^{th} Edition, BPB Publications, 2018.

R3. Pradip Dey, Manas Ghosh, “Computer Fundamentals and Programming in C”, 2^{nd} Edition, Oxford University Press, 2013.

Web References:

1. **http://www.cprogramming.com/**
2. **http://www.c4learn.com/**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	-	-	-	2	-	-	-	-	-
CO2	3	2	1	2	2	-	-	-	2	-	-	-	-	-
CO3	3	2	1	2	2	-	-	-	2	-	-	-	-	-
CO4	3	2	1	2	2	-	-	-	2	-	-	-	-	-
CO5	3	2	1	2	2	-	-	-	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 19MESC4001	Course Title: ENGINEERING DRAWING (Common to AU, ME, MC, CS, IT, EC & EI)		
Course Category: Engineering Science		Course Level: Practice	
L:T:P (Hours/Week) 1: 0: 3	Credits:2.5	Total Contact Hours:60	Max. Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Develop skills for communication of concepts and ideas.
2. Expose them to existing national standards related to technical drawings.

Unit I Orthographic Projection 12

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Projection of points, Projection of straight lines located in the first quadrant. Determination of true lengths and true inclinations. Visualization principles –conversion of pictorial into orthographic views.

Unit II Projection of Solids 12

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.

Unit III Projection of Sectioned Solids 12

Sectioning of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by cutting planes inclined to one reference plane and perpendicular to the other – Orthographic views of sections of simple solids.

Unit IV Development of Surfaces 12

Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders and cones.

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Unit V Isometric Projection 12

Principles of isometric projection – Isometric scale –Isometric projections of simple solids and truncated solids.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Sketch the orthographic projections of the given pictorial view of the object using first angle projection.	Apply
CO2: Sketch the projections of simple solids such as prism, pyramid, cylinder and cone using rotating object method.	Apply
CO3: Sketch the projections of simple sectioned solids with all necessary dimensions meeting the standards.	Apply
CO4: Sketch the lateral surface of simple solids using straight line and radial line development methods.	Apply
CO5: Sketch the isometric view of simple solids and truncated solids using principles of isometric projection.	Apply

Text Book(s):

T1. Cencil Jensen, Jay D.Helsel and Dennis R. Short, " Engineering Drawing and Design", Tata McGraw Hill India, New Delhi, 7th edition, 2017.

T2. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, Gujarat, 53rd edition, 2015.

T3. K. V. Natrajan, "A Text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 48th edition, 2018.

Reference Book(s):

R1. BasantAgarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill India, New Delhi, 2nd edition, 2013.

R2. John K.C., "Engineering Graphics", PHI Learning, Delhi, 1st edition, 2009.

R3. Dhananjay A. Jolhe, "Engineering Drawing with an introduction to AutoCAD" Tata McGraw India, New Delhi, 3rd edition, 2008.

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PUBLICATIONS OF BUREAU OF INDIAN STANDARDS

1. IS 10711 – 2001: Technical products Documentation – Size and lay out ofdrawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods. The mode of delivery is like practical.

Web References:

1. **http://nptel.ac.in/courses/112103019/**
2. **https://en.wikipedia.org/wiki/Engineering_drawing**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	2	3	2	-	1	-	-
CO2	3	2	2	2	-	-	-	2	3	2	-	1	-	-
CO3	3	2	2	2	-	-	-	2	3	2	-	1	-	-
CO4	3	2	2	2	-	-	-	2	3	2	-	1	-	-
CO5	3	2	2	2	-	-	-	2	3	2	-	1	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td>Course Code: 19PSHG3001</td><td colspan="3">Course Title: WELLNESS FOR STUDENTS
(Common to all B.E/B.Tech Programmes)
(2019 Batch Only)</td></tr>
<tr><td colspan="2">Course Category: Humanities</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 0: 0: 2</td><td>Credits:1</td><td>Total Contact Hours:30</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Articulate the importance of wellness for success in life.
2. Understand the dimensions of wellbeing and relevant practices
3. Guide in adopting such practices to improve wellness
4. Reflect the impact of changes sensed on personal and social effectiveness

UNIT I Wellness - Importance And Dimensions

Values and aspirations – goals – SMART Goals – means for achieving goals – job Vs career – success in life – attributes of successful persons. Maslow's Hierarchy of needs motivation - Concept of wellness – impact of absence of wellness - Wellness as important component to achieve success.

Wellbeing as per WHO - Dimensions of Wellbeing: Physical, Mental, Social, Spiritual – indicators and assessment methods – Guna – causes and impact - multiple dimensions of human structure (physical, astral, causal bodies) – human-panchabootha relationship.

UNIT II Practices for Physical Wellness through Yoga

Simplified Physical Exercises: Hand, Leg, Neuromuscular breathing, eye exercises, kapalabathy, makarasanam 1 & 2, body massage, 14-points acupressure – Suryanamaskar - relaxation. Simple asanas.

UNIT III Practices for Physical Wellness through Exercises

Fitness as a subset of Wellness – health related physical fitness - skill related physical fitness. Exercises related ailment and injuries - safety and precautions - first aid.

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Fitness development: Muscular strength – exercises (calisthenics): pull-up, sit-up, push-up and weight training; Explosive power – exercises: vertical jump, long jump; Cardio respiratory endurance– exercises: walking, jogging, treadmill, stair climbing, bicycling, skipping; Flexibility – exercises: stretching.

Speed, agility, balance and coordination – exercises: sprint, cone drill, ladder drill, hurdle drill, ball throw - mental agility exercises.

UNIT IV Practices for Mental Wellness

Meditation: Mind and its functions - mind wave frequency - Agna, Thuriyam and Shanthi meditation – introspection: analysis of thoughts, moralization of desire, neutralization of anger and eradication of worries - simple mindfulness exercises.

UNIT V Practices for Social and Spiritual Wellness

Kayakalpa yoga - youthfulness and life force - cultural education – greatness of guru – universal compassion – fivefold culture. Greatness of friendship and social welfare – individual, family and world peace – blessings and benefits.

Food & sleep for wellness: balanced diet - good food habits for better health (anatomic therapy) – hazards of junk food - food and the gunas.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concept of wellness and its importance to be successful in career and life	Understand
CO2: Explain the dimensions of wellness and practices that can promote wellness	Understand
CO3: Demonstrate the practices that can promote wellness	Understand
CO4: Sense and improve the wellness periodically and its impact on personal effectiveness	Understand
CO5: Maintain harmony with self, family, peers, society and nature	Understand

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Text Book(s):

T1. Reading material and workbook prepared by PS team of the college.

Reference Book(s):

R1. Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar ,“Value education for harmonious life (Manavalakalai Yoga)”, Vethathiri Publications, Erode, 1st Ed. 2010.

R2. Dr.R.Nagarathna, Dr.H.R.Nagendra, “Integrated approach of yoga therapy for positive health”, Swami Vivekananda Yoga Prakashana, Bangalore, 2008.

R3. Tony Buzan, Harper Collins, The Power of Physical Intelligence (English).

Course offering:

Orientation programme (3 days)	CO1 and CO2
Student practice (weekly review classes)	CO3
Student journal writing (interim reviews)	CO4 and CO5

Evaluation:

Continuous assessment: 75 marks

Yoga:

Physical Exercises, KayaKalpa = 15 marks

Meditation = 15 marks

Assessment of student’s workbook = 10 marks

Total = 40 marks

Sports:

Physical Exercises, KayaKalpa = 20 marks

Assessment of student’s workbook = 15 marks

Total = 35 marks

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End Semester Examination (combined for yoga and sports):

Written test (MCQ and short answers)	= 30 marks
Physical exercises	= 50 marks
Viva-voce	= 20 marks
Total	= 100 marks

End semester mark out of 100 is reduced to 25 marks. The student should get a total of 50 marks put together for a pass.

Scheme of wellness measurement:

#	Wellbeing Dimensions	Sub-dimensions	Wt. in total score	Measurement	Sub-dim score
1	Physical Wellbeing (40%)	BMI	16	weight & height	16
		Flexibility	12	Sit & reach test	12
		Endurance (Energy)	12	12 min Cooper run test	12
2	Mental wellbeing (30%)	Attention/ Concentration	12	Stroop test	15
		Memory	9	Digit Forward and Backward Test.	15
3	Social wellbeing (20%)	Inter-personal	10	IDEA & General Health Questionnaire	10
		Emotional wellbeing	5	IDEA questionnaire	5
		Self concept	5	IDEA questionnaire	5
4	Spiritual Wellbeing (10%)	Guna	10	Guna Questionnaire	
		Total	100%		100

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Semester II

<table>
<tr><td rowspan="1">Course Code: 19MABC1201</td><td colspan="3">Course Title: ORDINARY DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES
(Common to AU, CE, MC, ME, EC, EI, EE)</td></tr>
<tr><td colspan="2">Course Category: Basic Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 1: 0</td><td>Credits:4</td><td>Total Contact Hours:60</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Matrices and Calculus

Course Objectives:

The course is intended to:

1. Explain the concepts of vector differentiation and integration.
2. Construct analytic functions.
3. Use the concept of complex integration to evaluate definite integrals.
4. Determine the solution of second and higher order ordinary differential equations.
5. Apply Laplace transform techniques to solve ordinary differential equations.

UNIT I Vector Calculus 9+3

Gradient, Divergence, Curl, Line integrals, Surface integrals, Volume integrals, Theorems of Green, Gauss and Stokes (without proof) , Simple applications involving cubes, spheres and rectangular parallelepipeds.

UNIT II Complex Variables (Differentiation) 9+3

Cauchy-Riemann equations – Analytic functions – Properties – Harmonic functions – Finding harmonic conjugate – Conformal mapping (w=z+a, w= az, w=1/z) – Mobius transformation and their properties.

UNIT III Complex Variables (Integration) 9+3

Contour integrals – Cauchy Integral formula (without proof) – Cauchy Integral theorem – Taylor's series – Singularities of analytic functions – Laurent's series–Residues – Cauchy Residue theorem (without proof) – Evaluation of real definite integrals around unit circle and semi circle (Excluding poles on the real axis).

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UNIT IV Ordinary Differential Equations of Higher Orders 9+3

Second and higher order linear differential equations with constant coefficients – Second order linear differential equations with variable coefficients (Cauchy - Euler equation–Legendre's equation) – Method of variation of parameters – Solution of first order simultaneous linear ordinary differential equations.

UNIT V Laplace Transform 9+3

Laplace Transform – Properties of Laplace Transform – Laplace transform of integrals – Laplace transform of periodic functions -Inverse Laplace transforms - Convolution theorem – Solution of ordinary differential equations by Laplace Transform method– Applications on engineering problems.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concepts of vector differentiation and integration.	Apply
CO2: Use the concept of complex variables to construct analytic functions	Apply
CO3: Use the concept of complex integration to evaluate definite integrals.	Apply
CO4: Determine the solution of second and higher order ordinary differential equations	Apply
CO5: Apply Laplace transform techniques to solve ordinary differential equations	Apply

Text Book(s):

T1. Erwin kreyzig, "Advanced Engineering Mathematics", 10th edition, John Wiley & Sons, 2015.

T2. Veerarajan T., "Engineering Mathematics for First Year" , Tata McGraw-Hill, New Delhi, 2011.

Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 1st edition, 2017.

Reference Book(s):

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R1.G.B.Thomas and R.L Finney, “Calculus and Analytic Geometry”, 9th edition, Pearson, Reprint, 2010.

R2.N.P.Bali and Manish Goyel, “A Text book of Engineering Mathematics”, Laxmi Publication, 9th edition, 2010.

R3.B.S.Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 43rd edition, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/noc16_ma05
2. https://nptel.ac.in/courses/122101003/2

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	2	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	2	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	2	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	2	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 19ENHG2201	Course Title: COMMUNICATION SKILLS - II (Common to all B.E/B.Tech Programmes)		
Course Category: Humanities		Course Level: Practice	
L:T:P (Hours/Week) 2: 0: 2	Credits:3	Total Contact Hours:60	Max. Marks:100

Pre-requisites:

- Communication Skills - I

Course Objectives:

The course is intended to:

1. Listen and understand monologues and dialogues of a native speaker on par with B2 of CEFR level.
2. Speak in simple sentences to convey their opinion and ideas on par with B2 of CEFR level.
3. Read and infer a given text on par with B2 of CEFR level.
4. Draft basic formal written communication on par with B2 of CEFR level.

UNIT I Listening 15

Importance and purpose of attentive listening - Importance and purpose of intensive listening - Body Language – active listening on complex and abstract themes- Correlating Ideas related to listening input – importance of empathetic- listening for main ideas – paraphrase – compound and complex sentences - Developing ideas - Compose paragraphs.

UNIT II Speaking 15

Jotting down ideas collected from listening to speak – organising the ideas – Expressing one's view coherently – Understanding grammatical elements (Noun – Pronoun Antecedent) – Expressing ideas assertively – Answering questions during presentations – Understanding the use of discourse markers – word stress and sentence stress – voice modulation and pauses – Highlighting significant points – interpretation of visual data – Using verbal cues - Preparing simple hand - outs.

UNIT III Reading **15**

Reading strategies - Scanning – Inferring - Barriers to reading – sub vocalisation, Eye fixation, Regression – Speed Reading Techniques - read different texts and their context with speed – Note making – Reading a review – Paraphrasing - Read and comprehend.

UNIT IV Writing **15**

Reported speech& Concord (Subject - verb Agreement) – structure of the report – Report writing- Proposal –Plagiarism –references –appendices – Techniques for report writing – Registers.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Listen actively and empathetically, and paraphrase discussions and presentations on complex and abstract themes and topics.	Apply
CO2: Express one's views coherently, fluently and confidently highlighting the significant points with supporting details.	Apply
CO3: Read and comprehend with speed, different texts and their contexts reasonably at moderate speed.	Understand
CO4: Write detailed reports on variety of subjects synthesizing information gathered during listening & reading citing appropriate references.	Apply

Text Book(s):

T1. Whitby Norman, Business Benchmark Upper Intermediate Students' Book CUP Publications, 2nd Edition, 2014.

T2. Learners Book prepared by the Faculty members of Department of English.

Reference Book(s):

R1. Cambridge BEC Vantage - Practice Tests, Self-study Edition, Cambridge University Press, 2002.

R2. Hewings Martin - Advanced Grammar in use - Upper-intermediate Proficiency, CUP,

Web References:

1. http://www.grammarinenglish.com

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2. https://www.northshore.edu/support_centre /pdf/listen-notes.pdf
3. http://www.examenglish.com/BEC/BEC_Vantage.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PS
CO1	-	-	-	-	-	-	-	2	1	3	-	1	-	1
CO2	-	-	-	-	-	-	-	2	1	3	-	1	-	1
CO3	-	-	-	-	-	-	-	2	1	3	-	1	-	1
CO4	-	-	-	-	-	-	-	2	1	3	-	1	-	1
CO5	-	-	-	-	-	-	-	2	1	3	-	1	-	1

High-3; Medium-2; Low-1

Course Code: 19CHBC2201	Course Title: CHEMISTRY FOR MECHANICAL SCIENCES (Common to AU, ME, MC)		
Course Category: Basic Science		Course Level: Introductory	
L:T:P (Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours:75	Max. Marks:100

Pre-requisites

- Higher Secondary Chemistry I and II

Course Objectives

The course is intended to:

1. Calculate hardness of water based on water quality parameters.
2. Explain batteries based on their characteristics, construction, working principle and applications.
3. Explain the mechanism of corrosion and its control techniques.
4. Identify a suitable plastic for a specific engineering application.
5. Describe the characteristics of fuel and lubricants.

UNIT I Water Technology **9**

Hardness (Definition, Types, Units) - problems - Estimation of Hardness (EDTA Method) - Water softening - Carbonate conditioning and Calgon conditioning - Demineralization (Ion-Exchange Method) - Water Quality Parameters - Municipal Water Treatment - Desalination - Reverse Osmosis. Effluent discharge standards for Sewage Treatment Plants (STP) - pH, TSS, BOD, COD, NH_4-N, N-total and Fecal Coliform - Construction and working of a typical **S**equential **B**atch **R**eactor STP.

UNIT II Electrochemistry and Batteries **9**

Cells – Types of cells – Galvanic and electrolytic cells – emf and its measurement – Nernst equation - Batteries – Characteristics and Classifications of batteries, Construction, working and applications - Dry cells, Alkaline battery, Lead –Acid battery, Nickel-Cadmium battery, Lithium ion battery, Hydrogen -Oxygen Fuel Cell.

UNIT III Corrosion and Its Control **9**

Corrosion – dry and wet corrosion – mechanism of electrochemical corrosion – galvanic corrosion and concentration cell corrosion - Factors influencing corrosion. Corrosion control methods – Cathodic protection methods, Metallic coating – Galvanizing - Tinning – Chrome plating - Electroless plating of plastics (Nickel plating) - Powder coating - Electrophoretic deposition.

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UNIT IV Polymers, Plastics and Composites 9

Polymers – homo polymer and copolymer. Thermoplastics - thermosetting plastics - thermoplastic elastomers (TPE). Engineering plastics - PA, PC, PVC and Nylon 6, 6 – synthesis, properties and applications. Polymer Additives and Reinforcements-Thermal and light stabilizers, antioxidants, and flame retardants - Polymer composites – FRP and ceramic matrix composites.

UNIT V Fuels and Lubricants 9

Automotive fuels - Petrol, Diesel, CNG, Blended fuels - composition, properties and uses. Gross calorific and Net calorific value. Knocking in petrol and diesel engines – octane number and cetane number. Lubricants - importance of lubrication - Classification of lubricants **-** properties of liquid lubricants and its significance - Total Acid number and Total Base Number. Greases – common grease types and properties. Components of grease - Base Oil, Additives and Thickener. NLGI consistency number.

LIST OF EXPERIMENTS

1. Estimation of Hardness of water by EDTA method.
2. Determination of corrosion rate by weight loss method.
3. Estimation of Fe^{2+} by potentiometric titration
4. Determination strength of acid by pH metry.
5. Conductometric titration of strong acid against strong base.
6. Determination of molecular weight of polymer by Viscometric method.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Calculate hardness of water based on water quality parameters associated with water conditioning methods.	Understand
CO2: Explain batteries based on their characteristics, construction, working principle and applications.	Understand
CO3: Explain the mechanism of corrosion and its control techniques.	Understand
CO4: Identify a suitable plastic for a specific engineering application.	Understand
CO5: Describe the characteristics of fuel and lubricants based on their composition and applications.	Understand

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Text Book(s):

T1. Jain &Jain, "Engineering Chemistry" 17th edition, Dhanpat Rai Publishing Compan Ltd, New Delhi, 2018.

T2. Wiley Engineering Chemistry, 2nd edition, Wiley India Pvt Ltd, New Delhi. 2011.

Reference Book(s):

R1. Dara S.S.,and Umare S.S., "A Text book of Engineering Chemistry" ,S.Chand & Co Ltd,New Delhi, 2014.

R2. V.R.Gowariker ,N.V.Viswanathan and Jayadev Sreedhar,"Polymer Science," New Age International (P) Ltd, Chennai, 2006.

R3. Renu Bapna and Renu Gupta, "Engineering Chemistry" ,Macmillan India Publisher Ltd, 2010.

R4. Jeffery G.H.,BassettJ.,Mendham J.and Denny R.C.,Vogel's "Text Book of Quantitative Chemical Analysis" ,Oxford, ELBS ,London, 2012.

R5. Shoemaker D.P. and C.W.Garland.," Experiments in Physical Chemistry", Tata McGraw-Hill Pub.Co.,Ltd., London, 2009.

Web References:

1. **http://nptel.ac.in/courses/122101001/downloads/lec.23.pdf**
2. **http://nptel.ac.in/courses/118104004/**
3. **http://nptel.ac.in/courses/104105039/**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	1	-	3	3	-	3	-	-
CO2	2	1	-	-	-	1	1	-	3	3	-	3	-	-
CO3	2	1	-	-	-	1	1	-	3	3	-	3	-	-
CO4	2	1	-	-	-	1	1	-	3	3	-	3	-	-
CO5	2	1	-	-	-	1	1	-	3	3	-	3	-	-

High-3; Medium-2;Low-1

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Course Code: 19MESC2001	Course Title: INTRODUCTION TO ENGINEERING (Common to AU, MC, ME, EC, EI & EE)		
Course Category: Engineering Science		Course Level: Introductory	
L:T:P (Hours/Week) 2: 0: 2	Credits: 3	Total Contact Hours:60	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Explain the career opportunities in engineering.
2. Explain how to acquire engineering competencies.
3. Explain how to remain, relevant and versatile as an engineer.
4. Observe engineering products and processes.
5. Take ownership for learning and development.
6. Identify and rectify unsafe conditions and acts.

UNIT I Careers Opportunities In Engineering 5

Technicians, engineers and scientists, history of engineering. 17 sustainable development goals set by UNO, concept of small e to big E. career choices for an engineer, types of industries, academia and research as career choices, entrepreneurship as a career choice, various departments in engineering industries, roles available in engineering industries. innate skills, learnt skills (competencies), graduate attributes, roles of engineers and the corresponding competencies, career opportunities in engineering in terms of roles & competencies

UNIT II Developing Specific Skills And Competencies 5

OBE Model, PEOs and POs, technical POs, professional POs, mapping with Graduate attributes, Classification of courses, resources available in the campus and e-resources, resources and facilities available to acquire specific competencies, on-campus and off-campus activities, the methods by which students can systematically involve in activities, significance of professional

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skill courses, plan for utilizing the resources and facilities to develop specific competencies.

UNIT III Staying Relevant Through Continuous Improvement /Environmental Versatility 7

Rate of change, technology life cycle (TLC), features of a dynamic and complex environment in which students operate or will operate, impact of globalization & technical advancements, importance of remaining, relevant and versatile in a dynamic and complex environment with the help of technology life cycle, activities/process to remain relevant and versatile, environmental scanning, Life- long learning.

UNIT IV Observe Every Product And Processes With An Engineering Perspective And Inquisitiveness 4

Product -Need, purpose - primary and secondary function, various stages of manufacturing and its processes. Product - assembly of several simple engineering devices/systems. Product-Parts, principles and laws (mechanical, electrical and electronics), functional relationship between the parts, role of programming in engineering products. Significance of materials and their advancements in improvements in product.

UNIT V Learning And Development Leveraging The Resources And Infrastructure 6

Process Of Learning, Situated Learning with Examples, Own Learning (Not Copying), Differences between Real Life and Simulated Environment, the Sprit Of Experimentation, Various Learning Enablers, Measure the performance against the plan.

UNIT VI Unsafe Conditions And Acts And Follows Environment Friendly Practices 3

Safety-definition, importance of personal safety. Statistics of road accidents. Unsafe condition and unsafe act- definition, cause and effects, identification of the unsafe conditions and acts in home/hostel, labs, class rooms, public places. Importance of environment friendly practices.

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List of Experiments: **30 Hours**

1. Career opportunities with roles and responsibilities.
2. Observe every product and processes with an engineering perspective and inquisitiveness.
    a. Primary and Secondary functions of products and their equivalents.
    b. Primary and Secondary functions of parts of the products, their manufacturing processes and materials.
    c. Structural and functional relations of the product.
3. Safe and unsafe acts and conditions in day-to-day life and professional practices.
4. Skills for Hobby project (At least TWO)
    a. Soldering and de-soldering practices.
    b. Circuit and component testing using multi-meter & CRO.
    c. Battery operated circuit connections and testing.
    d. Simple switching circuits using relays and transistors.
    e. Adhesives used in part assembly.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the career opportunities in engineering in terms of roles & competencies.	Understand
CO2. Explain how a student can acquire the competencies.	Understand
CO3. Explain how to remain, relevant and versatile in a dynamic and complex environment.	Understand
CO4. Observe every product and processes with an engineering perspective and inquisitiveness.	Apply
CO5. Choose to take ownership for his/her learning and development leveraging the resources and infrastructure.	Understand
CO6. Identify and rectify unsafe conditions and acts and follow environment friendly practices.	Understand

Text Book(s):

T1. Worksheets and Handouts prepared by MCET team.

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Reference Book(s):

R1. L. A Bloomfield, “How things work: The physics of everyday life”, WILYS 5th Edition, 2013

R2. C. Mason, “How things work,” Usborne Publishing Ltd 2009.

R3. D.K. Publishing, “How things work encyclopedia”, 2009.

R4. R. J. Segalat, “How things work”, Edito-Service Vol.I-IV, 1990.

Web References:

1. https://en.wikibooks.org/General_Engineering_Introduction/Engineering_Science
2. https://science.howstuffworks.com/engineering-channel.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	3	1	-	1	-	2
CO2	2	1	-	-	-	2	2	1	3	1	-	1	-	2
CO3	2	1	-	--	-	2	2	1	3	1	-	1	-	2
CO4	3	2	1	1	-	2	2	1	3	1	-	1	-	2
CO5	2	1	-	--	-	2	2	1	3	1	-	1	-	2
CO6	2	1	-	-	-	2	2	1	3	1	-	1	-	2

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19MESC2201</td><td colspan="2">Course Title: ENGINEERING MATERIALS
(Common to AU,MC, ME)</td></tr>
<tr><td colspan="2">Course Category: Engineering Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week) 2: 0: 2</td><td>Credits:3</td><td>Total Contact Hours:60</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Calculate the crystal parameters.
2. Understand the phase diagram.
3. Understand the behaviour of ferrous and nonferrous alloy.
4. Understand the powder metallurgy technique.
5. Understand the heat treatment processes.

UNIT I Crystal Physics 9

Introduction: Crystalline and Non crystalline materials. Single crystal , Polycrystalline materials Anisotrophic crystal parameters: Atomic radius, Number of atoms per unit cell, Coordination number, atomic packing factor for SC , BCC , FCC and HCP- Crystal planes: Miller indices, Braggs law . Interplanar distance- Polymorphism and allotrophy. Crystal imperfections: Point , line , surface and volume , grain boundary and its role in mechanical properties.

UNIT II Constitution of Alloys and Phase Diagrams 9

Constitution of alloys- Solid solutions- Substitutional and Interstitial. Phase diagrams- Interpretation of Phase diagram, Lever rule, Gibbs phase rule. cooling curve for pure metal, binary solid solution and binary eutectic system. Iron – Iron Carbide equilibrium diagram. Micro constituents in Fe_3C diagram (Austenite, Ferrite, Cementite, Pearlite, Martensite, Bainite), Pearlite transformation.

UNIT III Ferrous and Nonferrous Alloy **9**

Ferrous alloy: Effect of alloying elements on properties of steel (Mn, Si, Cr, Mg, V and W). Properties and applications of stainless steel and Tool steel, Cast Iron-White, Malleable, Grey and Spheroidal Cast Iron-Properties and Applications

Non Ferrous alloy: Aluminium and its alloys, Copper and its alloys, Magnesium and its alloys, Titanium and its alloys, Nickel and its alloys- Composition, Properties and Applications.

Industrial standards for alloys and other materials - alloying elements and inclusion of ceramics materials.

UNIT IV Powder Metallurgy **9**

Need of powder metallurgy products-Advantages and limitation of P/M-Stages in P/M-Need for additives in P/M-secondary process of P/M products-mechanical-physical-chemical methods of powder production-compaction and sintering techniques of P/M-particle size analysis

UNIT V Heat Treatment **9**

Heat treatment process-purpose heat treatment – Process parameters. Bulk treatment: Annealing, Normalizing, Tempering, Quenching (Process parameter, application). Isothermal transformation Diagram (TTT Diagram). Cooling curves superimposed on TTT diagram.CCR. Harden ability- Definition. Method to determine Harden ability- Jominy end quench test.

List of Experiments **15**

1. Determine the hardness of the given specimen.
2. Determine the toughness of the given specimen.
3. Draw the microstructure of cast iron, steel and aluminum using Metallurgical microscope.
4. Prepare a specimen using mounting press for metallographic examination.
5. Microstructure characterization of the polished specimen.

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Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the crystal parameters for different crystal structure and its influences on mechanical properties of bulk materials.	Understand
CO2: Explain the changes of phase diagram with respect to an alloy by Gibbs phase rule and infer its property for a given composition.	Understand
CO3: Understand the behaviour changes of Ferrous and Non Ferrous alloy for a suitable application.	Understand
CO4: Understand the powder metallurgy technique, based on the functional requirement of the product.	Understand
CO5: Understand the heat treatment process for the given ferrous alloy such as steel, cast iron for a suitable application.	Understand

Text Book(s):

T1. William D Callister "Material Science and Engineering", John Wiley and Sons, 2014.

T2. Sidney H Avner "Introduction to Physical Metallurgy", Tata McGRAW-Hill, 2017.

T3. Anup Goel, SS Sabharwal, "Engineering Materials and Metallurgy", Technical Publication, 2014.

Reference Book(s):

R1. Raghavan.V "Materials Science and Engineering", Prentice Hall of India Pvt., Ltd., 2015.

R2. Dieter G. E., "Mechanical Metallurgy", McGraw Hill Book Company, 2013.

R3. Kenneth G. Budinski. "Engineering Materials", Prentice Hall of India, New Delhi 2010.

R4. Y. Lakhtin, "Engineering Physical Metallurgy", CBS Publisher, New Delhi, 2012.

Web References:

1. http://nptel.ac.in/courses/113106032/
2. http://www.nptel.ac.in/courses/112108150/
3. https://en.wikipedia.org/wiki/Materials_science

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	3	1	-	2	-	-
CO2	2	1	-	-	-	-	-	1	3	1	-	2	-	-
CO3	2	1	-	-	-	-	-	1	3	1	-	2	-	-
CO4	2	1	-	-	-	-	-	1	3	1	-	2	-	-
CO5	2	1	-	-	-	-	-	1	3	1	-	2	-	-

High-3; Medium-2;Low-1

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Course Code: 19MECC3201	Course Title : ENGINEERING PRACTICES LABORATORY (Common to AU, ME, MC)		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 0: 0: 3	Credits:1.5	Total Contact Hours:45	Max. Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Draw the basic symbols of electrical and electronic components and identify the elements.
2. Execute soldering practice for electrical and electronic circuits.
3. Demonstrate the basic carpentry, fitting, plumbing, sheet metal and welding operations.

List of Experiments:

[A] Electrical & Electronics :

1) Symbols of electrical and electronic components and study of electrical drawing.
2) Insulation Testing using Megger.
3) Soldering practice of simple circuit and testing.
4) Fluorescent tube, staircase and house wiring.
5) Verification of Kirchhoff's current and voltage law.

[**B] Civil & Mechanical :**

1) Make a wooden Tee joint to the required dimension.
2) Make a "V" filling to the required dimension using fitting tools.
3) Make a tray in sheet metal to the required dimension.
4) Assemble the pipeline connections with different joining components for the given layout.
5) Weld a butt joint using welding process to the required dimension.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Draw the basic symbols of electrical and electronic components from a given circuit.	Apply
CO2: Connect the electrical and electronic components andother house holding items as per the given circuit.	Apply
CO3: Verify the Kirchhoff's laws as per the given circuit.	Apply
CO4: Make a wooden 'T' joint, metal 'V' joint, sheet metal 'TRAY', pipeline with various joining components and a permanent joint using various workshop tools as per the given dimensions.	Apply

Reference(s):

R1. Jeyachandran.K, Natarajan.S & Balasubramanian.S, "A Primer on Engineering Practices Laboratory", Anuradha Publications, TamilNadu (India), 2016.

R2. 19EPL21 - Engineering practices laboratory Manual.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	2	3	2	-	-	-	-
CO2	3	2	2	2	1	-	-	2	3	2	-	-	-	-
CO3	3	2	2	2	1	-	-	2	3	2	-	-	-	-
CO4	3	2	2	2	1	-	-	2	3	2	-	-	-	-

High-3; Medium-2;Low-1

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<table>
<tr><td colspan="2">Course Code: 19PSHG3002</td><td colspan="3">Course Title: PERSONAL EFFECTIVENESS
(Common to all B.E/B.Tech Programmes)
(2019 Batch Only)</td></tr>
<tr><td colspan="3">Course Category: Humanities</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 0: 0: 2</td><td colspan="2">Credits:1</td><td>Total Contact Hours:30</td><td>Max.Marks:100</td></tr>
</table>

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Set SMART goals for academic, career and life.
2. Identify strength, weaknesses and opportunities.
3. Plan for achieving the goals.
4. Apply time management techniques.
5. Create time and pursue activities of self interest.

UNIT I The Importance of Envisioning

Importance of positive self-perception – Principle of dual creation (Everything gets created twice – Envisioning) - Understanding Vision and mission statements - Writing personal mission statements – 'Focus' as a way of life of most successful people – Importance of goal setting –Importance of planning and working to time.

UNIT II Fundamental Principles of Goal Setting and Working to Time

Clarifying personal values, interests and orientations – Awareness of opportunities ahead – Personal SWOT analysis - Principles driving goal setting: Principle of response and stimuli, Circle of influence and circle of concern, What you see depends on the role you assume.

UNIT III Goal Setting and Action Orientation

Potential obstacles to setting and reaching your goals - Five steps to goals setting: SMART goals, Inclusive goals, Positive stretch, Pain vs gain, Gun-point commitment – Importance of action orientation - Converting goals to actionable tasks – Establishing road map – Using Gantt chart for planning and progress.

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UNIT IV Time Management - Tools and Techniques

Pareto 80-20 principle of prioritization – Time quadrants as a way to prioritize weekly tasks – The glass jar principle - Handling time wasters – Assertiveness, the art of saying 'NO' – Managing procrastination.

UNIT V Putting into Practice

Practicals: Using the weekly journal – Executing and achieving short term goals – Periodic reviews.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Identify the strengths, weaknesses and opportunities.

CO2: Set well-articulated goals for academics, career, and personal aspirations.

CO3: Establish the road map to realize the goals.

CO4: Apply time management techniques to complete planned tasks on time.

CO5: Create time and pursue activities of self-interest that add value.

Text book(s):

T1. Reading material, workbook and journal prepared by PS team of the college.

References:

R1. Stephen R Covey, "First things first", Simon & Schuster U.K, Aug 1997.

R2. Sean Covey, "Seven habits of highly effective teenagers", Simon & Schuster U.K, 2004.

Course offering:

Orientation programme (2 days)	CO1 and CO2
Student practice (weekly review classes)	CO3
Student journal writing (interim reviews)	CO4 and CO5

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<table>
<tr><td colspan="2" rowspan="3">Course Code: 19PSHG6001</td><td colspan="3">Course Title: WELLNESS FOR STUDENTS</td></tr>
<tr><td colspan="3">(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">(2020 Batch Only)</td></tr>
<tr><td colspan="3">Course Category: Humanities</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 0: 0: 2</td><td colspan="2">Credits:1</td><td>Total Contact Hours:30</td><td>Max.Marks:100</td></tr>
</table>

Course Objectives

The course is intended to

1. Set SMART goals for academic, career and life
2. Apply time management techniques
3. Articulate the importance of wellness for success in life.
4. Understand the dimensions of wellbeing and relevant practices
5. Demonstrate the practices that can promote wellness

UNIT I GOAL SETTING

Understanding Vision and mission statements - Writing personal mission statements – ‘Focus’ as a way of life of most successful people. Clarifying personal values, interests and orientations – Awareness of opportunities ahead – Personal SWOT analysis - Principles driving goal setting: Principle of response and stimuli, Circle of influence and circle of concern, What you see depends on the role you assume. Potential obstacles to setting and reaching your goals - Five steps to goals setting: SMART goals, Inclusive goals, Positive stretch, Pain vs gain, Gun-point commitment.

UNIT II TIME MANAGEMENT - TOOLS AND TECHNIQUES

Importance of planning and working to time. Pareto 80-20 principle of prioritization – Time quadrants as a way to prioritize weekly tasks – The glass jar principle - Handling time wasters – Assertiveness, the art of saying ‘NO’ – Managing procrastination

UNIT III PRACTICES FOR PHYSICAL WELLNESS

Concept of wellness – impact of absence of wellness - Wellness as important component to achieve success. Wellbeing as per WHO - Dimensions of Wellbeing: Physical, Mental, Social, Spiritual – indicators and assessment methods

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Simplified Physical Exercises. Fitness as a subset of Wellness – health related physical fitness - skill related physical fitness. Joint movements, Warm up exercises, simple asanas, WCSC simplified exercises.

UNIT IV PRACTICES FOR MENTAL WELLNESS

Meditation: Mind and its functions - mind wave frequency – Simple basic meditation – WCSC meditation and introspection tables. Greatness of friendship and social welfare – individual, family and world peace – blessings and benefits.

Food & sleep for wellness: balanced diet - good food habits for better health (anatomic therapy) – hazards of junk food - food and the gunas.

UNIT V PUTTING INTO PRACTICE

Practicals: Using the weekly journal – Executing and achieving short term goals – Periodic reviews

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Set well-articulated goals for academics, career, and personal aspirations	Understand
CO2: Apply time management techniques to complete planned tasks on time	Understand
CO3: Explain the concept of wellness and its importance to be successful in career and life	Understand
CO4: Explain the dimensions of wellness and practices that can promote wellness	Understand
CO5: Demonstrate the practices that can promote wellness	Understand

Text book(s):

Reading material, workbook and journal prepared by PS team of the college.

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Reference(s):

R1 Stephen R Covey, “First things first”, Simon & Schuster Uk, Aug 1997.

R2 Sean Covey, “Seven habits of highly effective teenagers”, Simon & Schuster Uk, 2004.

R3 Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar, “Value education for harmonious life (Manavalakalai Yoga)”, Vethathiri Publications, Erode, I Ed. (2010).

Course offering: (Annual Pattern)

CO1, CO2 and CO5	Can be conducted in Odd semester
CO3, CO4 and CO5	Can be conducted in Even semester
Student journal writing (interim reviews)	CO1 to CO5

Evaluation:

Continuous assessment: 75 marks

Personal Effectiveness = 35 marks (Odd Sem)

Yoga and physical Exercise (Even Sem)

Physical Exercises = 20 marks

Meditation = 10 marks

Assessment of student’s workbook = 10 marks

End Semester Examination (combined for yoga and sports):

Written test (MCQ and short answers) = 30 marks

Physical exercises = 50 marks

Viva-voce = 20 marks

Total = 100 marks

End semester mark out of 100 is reduced to 25 marks.

The student should get a total of 50 marks put together for a pass.

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Course Code: 19CHMG6201	Course Title: ENVIRONMENTAL SCIENCES (Common to all B.E/B.Tech Programmes)		
Course Category: Mandatory		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0: 0	Credits: 0	Total Contact Hours:15	Max. Marks: 0

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Create awareness for conservation and equitable use of natural resources.
2. Explain the measures of prevention of pollution and disaster management.
3. State the importance of environmental legislation in India.
4. Expose the general environmental issues relevant to human health.
5. Explain the innovative measures for day to day environmental issues.

UNIT I Natural Resorouces 2

Role of individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT II Environmental Pollution And Disaster Management 2

Role of an individual in prevention of pollution; Disaster management : floods, earthquake, cyclone and landslides.

UNIT III Environmental Ethics And Legislations 2

Environmental ethics : Environment Protection Act; Air Act; Water Act ; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation.

UNIT IV Environmental Issues And Public Awarness 2

Public awareness - Environment and human health.

UNIT V Environmental Activities 7

(a) Awareness Activities:

i) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste.

ii) Slogan making event.

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iii) Poster making event.

(b) Actual Activities:

i) Plantation.

ii) Cleanliness drive.

iii) Drive for segregation of waste.

iv) To know about the different varieties of plants.

v) Shutting down the fans and ACs of the campus for an hour or so.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Create awareness for conservation and equitable use of natural resources.	Understand
CO2: Explain the measures of prevention of pollution and disaster management.	Understand
CO3: State the importance of environmental legislation in India.	Understand
CO4: Expose the general environmental issues relevant to human health.	Understand
CO5: Explain the innovative measures for day to day environmental issues.	Understand

TEXTBOOKS:

T1. Benny Joseph, "Environmental Studies‟, Tata McGraw Hill, New Delhi, 2006.

T2. Mackenzie Davis and Susan Masten, "Principles of Environmental Engineering and science", Mc-Graw Hill, 3rd edition, 2014.

REFERENCES:

R1. Trivedi R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards‟, Vol. I and II, Enviro Media.

R2. Cunningham, W.P.Cooper., T.H. Gorhani, "Environmental Encyclopedia‟, Jaico Publishing House, Mumbai, 2001.

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COURSE ARTICULATION MATRIX

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	3	3	1	-	1	-	1	-	-
CO2	2	1	-	-	-	3	3	1	-	1	-	1	-	-
CO3	2	1	-	-	-	3	3	1	-	1	-	1	-	-
CO4	2	1	-	-	-	3	3	1	-	1	-	1	-	-
CO5	2	1	-	-	-	3	3	1	-	1	-	1	-	-

ASSESSMENT PATTERN

- Attendance : 10 Marks
- Knowledge Test : 40 Marks
- Activity(ies) : 50 Marks

Total Marks : 100

RUBRICS FOR ATTENDANCE

Component	Marks	Details
Attendance	10	Minimum 80%, 1 mark for each 5% observed
Knowledge Test	40	40 objective type questions from Induction Program
Activity(ies)	50	Rubrics based assessment

NON-LETTER GRADES

Marks Scored	Performance Level
70 & above	Good
30 – 69	Average
< 30	Fair

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Semester III

Course Code: 19MABC1301	Course Title: NUMERICAL METHODS (Common to AU & ME)		
Course Category: Basic Science		**Course Level: Introductory**	
L:T:P (Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours:60**	**Max. Marks:100**

Pre-requisites:

- Matrices and Calculus

Course Objectives:

The course is intended to:

1. Solve the system of linear equations and calculate dominant Eigen value.
2. Solve the non-linear equations and apply the principle of least squares to fit a curve to the given data.
3. Interpolate the given data and calculate the numerical derivatives and integration.
4. Solve the initial value problems using numerical techniques.
5. Solve the boundary value problems using numerical techniques.

UNIT I Solution of System of Linear Equations and Eigen value 9+3

Solution of system of linear equations – Gauss elimination method – Crout's method – Iterative methods of Gauss Jacobi and Gauss Seidal method – Eigen values of matrix by Power method.

UNIT II Solution of Non-Linear Equations and Curve Fitting 9+3

Solution of non-linear equations: Method of false position - Newton Raphson method – Order of convergence. Curve fitting: Method of least square – Fit a straight line – Fitting a curve.

UNIT III Interpolation, Polynomial Approximation and Numerical Integration 9+3

Interpolation with equal intervals – Newton's forward and backward difference formulae – Interpolation with unequal interval – Lagrange's interpolation – Numerical differentiation – Numerical integration – Trapezoidal rule, Simpson's rule – Double integration using Trapezoidal rule.

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UNIT IV **Initial Value Problem for Ordinary Differential Equations** **9+3**

Single step methods – Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations – Multi step methods – Milne's and Adams method.

UNIT V **Boundary Value Problems in Ordinary and Partial Differential Equations** **9+3**

Solution of two dimensional Laplace's and Poisson's equations – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Determine the solution of system of linear equations and also calculate the dominant Eigen value of a matrix.	Apply
CO2: Determine the solution of non-linear equations using numerical techniques.	Apply
CO3: Interpolate the given data and obtain the derivatives and integral at the required points.	Apply
CO4: Determine the solution of initial value problems using numerical techniques.	Apply
CO5: Determine the solution of boundary value problems using numerical techniques.	Apply

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Text Book(s):

T1. Erwin kreyzig, “Advanced Engineering Mathematics”, 10^{th} edition, John Wiley & Sons, 2015.

T2. Veerarajan T., “Engineering Mathematics for First Year” , Tata McGraw-Hill, New Delhi, 2011.

T3. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 1^{st} edition, 2017.

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9^{th} edition, Pearson, Reprint, 2010.

R2. N.P.Bali and Manish Goyel, “A Text book of Engineering Mathematics”, Laxmi Publication, 9^{th} edition, 2010.

R3. B.S.Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 43^{rd} Edition, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/noc16_ma05
2. https://nptel.ac.in/courses/122101003/2

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	1	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MESC1301	Course Title: ENGINEERING MECHANICS (Common to AU,ME & MC)		
Course Category: Engineering Science		**Course Level: Practice**	
L:T:P(Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours:60**	**Max Marks:100**

Pre-requisites

- Physics for Mechanical Sciences

Course Objectives

The course is intended to:

1. Draw the free body diagram.
2. Determine the magnitude of unknown forces in a given system.
3. Determine the geometric properties of bodies.
4. Determine the degrees of freedom.
5. Determine the kinetic parameters of rigid bodies

UNIT I Free body Diagram 9+3

Fundamental laws of mechanics (Review) - Freebody diagram – Statics - Particles and Rigid body (Beams, Frames and Machines) – Types of forces – Action (Point, UDL, UVL and couples) – Reaction (Supports, Friction) – Dynamics – Particles and Rigid body – Linear and Circular planar motions.

UNIT II Force Analysis of Beams, Frames and Machines 9+3

Governing equations of equilibrium – Equivalent force and couple moment – Types of beams – Determining reactions in statically determinate beams – Bending moment diagram and Shear force diagram of cantilever, simply supported beam and over hanging beams – Analysis of frames – Machines – Laws of dry friction – ladder, belt, wedge and screw frictions.

UNIT III Geometric Properties of Lamina and Bodies 9+3

Properties of surfaces – centroid of composite planes such as L, I and T – Moment of Inertia (MI) – Parallel and perpendicular axis theorem – MI of composite sections involving simple geometries such as rectangle, circle and triangle – Centre of gravity and mass moment of inertia of composite solids involving block, cylinder, cone and sphere.

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UNIT IV Introduction to Mechanisms 9+3

Mechanism and structure – links – pairs – chains – four bar and slider crank mechanisms - degrees of freedom of linkages – Gruebler's criterion – Grashof's condition of rotatability - transmission angle and mechanical advantage – special lower pair mechanisms: Peaucellier straight line mechanism, Ackermann steering mechanism, pantograph, Geneva mechanism.

UNIT V Kinetics of Rigid Body 9+3

Dynamic equilibrium of rigid bodies – Planar kinetics of rigid body – Force and Acceleration, Work and energy, Impulse and momentum.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Develop the free body diagram of particles and rigid bodies such as beams, frames and machines under static and dynamic conditions.	Apply
CO2: Determine various forces on rigid bodies such as beams, frames and machines under static conditions.	Apply
CO3: Calculate centroid, center of gravity and moment of inertia of simple shapes.	Apply
CO4: Determine the degrees of freedom of given mechanism.	Apply
CO5: Calculate the kinetic parameters of rigid bodies for dynamic equilibrium.	Apply

Text Book(s):

T1 R C Hibbeler, "Engineering mechanics – Statics and Dynamics", 14th Edition, Pearson, New Delhi, 2017.

T2 F.P. Beer and Jr. E.R. Johnston, "Vector Mechanics for Engineers – Statics and Dynamics", 10th Edition Tata McGraw Hill publishing company, New Delhi, 2017.

T3 S.S. Rattan, "Theory of Machines", McGraw Hill Education, 4th Edition. 2017.

Reference Book(s):

R1. James L. Meriam and L. Glenn Kraige, "Engineering mechanics (Statics and Dynamics)" 8th Edition. John Wiley & Sons, 2016.

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R2. R.S. Khurmi, J.K. Gupta, “Theory of Machines”, S.Chand, 14th Edition. 2005.

R3. Irving H. Shames, “Engineering mechanics – Statics and Dynamics”, 14th Edition, Pearson, New Delhi, 2014.

Web References:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
2. https://nptel.ac.in/courses/122104015/

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MECC2301	Course Title: FLUID MECHANICS AND HYDRAULIC MACHINERY (Common to AU, ME & MC)		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours:75	Max Marks:100

Prerequisites

- Physics for Mechanical Sciences

Course Objectives

The course is intended to:

1. Apply mathematical knowledge to predict the properties and characteristics of a fluid.
2. Analyze and calculate major and minor losses associated with pipe flow.
3. Mathematically predict the nature of physical quantities.
4. Select a suitable hydraulic pump for the customer provided site conditions.
5. Select a suitable hydraulic turbine for the given rated parameters.

UNIT I Fluid Properties and Flow Characteristics 9

Fluid: definition, classification of fluids, units and dimensions. Properties of fluids: density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, capillarity and surface tension.

Flow characteristics, Continuity equation and Bernoulli's equation in 1-D, Hydraulic and energy gradient. Application of Bernoulli's equation to flow through pipes, venturi meters, orifice meters and Pitot tube.

UNIT II Flow Through Circular Conduits 9

Laminar and Turbulent flow though circular conduits, boundary layer concepts, boundary layer thickness. Darcy-Weisbach equation, Friction factor and Moody diagram, Minor and Major losses, Flow though pipes in series and in parallel.

UNIT III Dimensional Analysis 9

Need for dimensional analysis, methods of dimensional analysis, Buckingham's π theorem. Similitude, types of similitude, Dimensionless parameters, application of dimensionless parameters, Model analysis.

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UNIT IV Pumps **9**

Centrifugal pump: working principle and working principle, velocity triangles, Euler pump equation, various efficiencies and performance curves.

Reciprocating pump: classification, working principle, indicator diagram, work saved by air vessels - performance curves.

UNIT V Hydraulic Turbines **9**

Classification of turbines, heads and efficiencies, velocity triangles, Euler turbine equation. Pelton, Francis and Kaplan turbines, working principle and construction, work done by water on the runner, draft tube, performance curves, governing of turbines.

List of Experiments **30**

1. Determination of coefficient of discharge of given Orifice meter.
2. Determination of coefficient of discharge of given Venturimeter.
3. Determination of friction factor of given set of pipes.
4. Performance study of Centrifugal pumps
5. Performance study of reciprocating pumps.
6. Performance characteristics of a Pelton wheel.
7. Performance test on a Francis Turbine.
8. Performance test on a Kaplan Turbine

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply mathematical knowledge to predict the properties and characteristics of a fluid.	Apply
CO2: Analyze and calculate major and minor losses associated with pipe flow in piping networks.	Apply
CO3: Mathematically predict the nature of physical quantities.	Apply
CO4: Select a suitable hydraulic pump for the customer provided site conditions.	Apply
CO5: Select a suitable hydraulic turbine for the given rated parameters.	Apply

Text Book(s):

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T1. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", 5th edition, Laxmi Publications (P) Ltd., New Delhi, 2014.

T2. Vasandani, V.P., "Hydraulic Machines - Theory and Design", 4th edition Khanna Publishers, 2014.

Reference Book(s):

R1. White, F.M., "Fluid Mechanics", 5th Edition Tata McGraw-Hill,New Delhi, 2013

R2. Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", 9th Edition McGraw-Hill education, 2017.

R3. Kumar, K.L., "Engineering Fluid Mechanics", 7th edition Eurasia Publishing House (P) Ltd., New Delhi, 2014.

Web References:

http://nptel.ac.in/courses/112107147/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	3	1	-	2	2	-
CO2	3	2	1	1	-	-	-	1	3	1	-	2	2	-
CO3	3	2	1	1	-	-	-	1	3	1	-	2	2	-
CO4	3	2	1	1	-	-	-	1	3	1	-	2	2	-
CO5	3	2	1	1	-	-	-	1	3	1	-	2	2	-

High-3; Medium-2; Low-1

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Course Code: 19MECN2301	Course Title: METROLOGY AND MEASUREMENT		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours:75	Max. Marks:100

Pre-requisites

- Engineering Drawing

Course Objectives

The course is intended to:

1. Explain tolerances and fits for parts and their assembly.
2. Select appropriate measuring instruments for given application.
3. Conduct measurement system analysis.
4. Explain physical measuring instruments.
5. Explain advanced measuring instruments.

UNIT I Fits and Tolerance 9

Definition of metrology – Types –requirements of metrology-Part tolerance: Nominal size-upper and lower specification-fundamental deviation-types of tolerance- importance of tolerance – selection of tolerance- tolerance grade- purpose of limits-types-importance of limits - Assembly tolerance: system and subsystem-importance of assembly tolerance-GD&T Symbols-datum-datum reference-Fits-Types-importance of fits-system of fit-selection of fit-application of fits.

UNIT II Measuring Instruments 9

Measuring instruments- types of measurements-variable-attributes, Linear measurements-Steel rule, Vernier caliper and its types, micrometer and its types, Height Vernier, Bore dial, Depth Vernier/ Micrometer, gauges -types , snap gauge, ring gauge ,plug gauge, thread gauge, types of comparators, mechanical, electrical, pneumatic comparator, Angular measuring instruments-Sine bar, Bevel protractor, Autocollimator, Angle dekkor, Form Measurements- Floating carriage micrometer, gear tooth Vernier caliper, surface roughness measurements, types of dimensions-functional –non-functional, different shapes of part- circular- prismatic component.

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UNIT III Measurement System Analysis 9

Static characteristics of measuring instruments- Accuracy, precision, sensitivity Threshold, Resolution, Repeatability, Reproducibility, Dead zone, backlash, hysteresis, Dynamic characteristics of an instrument- Speed of response, Fidelity, Lag, Dynamic error, Error, Classification of errors, Error Analysis, Calibration of an instrument.

UNIT IV Measuring Instruments for physical parameters 9

Flow and pressure measurement - Rotameter – Viscometer – pressure gauge. Vibration Measurement – Accelerometer. Speed measurement - Speedometer - Tachometer. Infrared thermometer - Principle and working. Electrical measurement instruments - Multimeter - Clampmeter. Light Measurement - Lux meter. Sound measurement - Sound meter.

UNIT V Advanced Measuring Instruments 9

Introduction - Mechanical Measuring Instruments - Coordinate Measuring Machine (CMM) - Importance - Types - Application. Roundness test - Importance - 3 Point Method -

Rotational drum method. Roughness test - Terms of surface texture - Importance - Roughness tester. 2D Microhite – Applications. Metallurgical Instruments – Spectrometer. Laser interferometer - Laser metrology - Laser interferometer.

List of Experiments 30

1. Measure the dimension of the given component using Vernier caliper
2. Determine the diameter of a cylindrical component of accuracy 0.01 mm using micrometer
3. Measure the thickness of gear tooth using gear tooth Vernier
4. Measure the height of the given component using Vernier height gauge
5. Measure thread parameter using profile projector.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain tolerances and fits required to specify parts and their assembly.	Understand
CO2: Select appropriate measuring instruments for the given parts, dimensions and tolerance.	Apply
CO3: Conduct measurement system analysis for the chosen measuring instruments.	Apply
CO4: Explain general measuring instruments for physical parameters.	Understand
CO5: Explain advanced measuring instruments based on the application.	Understand

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Text Book(s):

T1. Jain R.K., “Engineering Metrology”, 21st Edition, Khanna Publishers, 2018.

T2. Bewoor, Vinay A Kulkarni, “Metrology and Measurements”, 1st Edition, Mc Graw Hill, 2009.

T3. K.R.Gopalakrishna, “Machine Drawing” Subhas Publication, 2007.

Reference Book(s):

R1. P.S. Gill “Geometric Dimensioning and Tolerancing”, 2nd Edition, S.K. Kataria & Sons 2019.

R2. Gupta S.C, “Engineering Metrology”, 21st Edition, Dhanpat rai Publications, 2017.

R3. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, 2nd Edition, Pearson Education, 2006.

Web References:

1. https://nptel.ac.in/courses/112106179/
2. https://www.engineersedge.com/video/Geometric_Dimensioning_and_Tolerancing/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO
CO1	2	1	-	-	-	-	-	1	3	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	3	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	3	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	3	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	3	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MECN1301	Course Title: MANUFACTURING PROCESSES		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Pre-requisites:

- Physics for Mechanical Sciences
- Chemistry for Mechanical Sciences
- Engineering Practice Laboratory

Course Objectives:

The course is intended to:

1. Explain the metal casting and forging processes.
2. Explain the Plastic Moulding Processes.
3. Explain the metal forming and joining processes.
4. Explain the metal cutting processes.
5. Explain the metal Finishing processes.

UNIT I Metal Casting and Forging processes 10

Introduction to metal casting processes, Pattern and its types, allowances for pattern, Sand casting process, Centrifugal casting process, Die Casting process, Furnace and its types, Defects in castings processes.

Introduction to Forging processes, Forging operations, Types of forging, forging machines, Defects in forgings processes, Rolling process and defects, Extrusion process, Wire and Rod drawing.

UNIT II Plastic Moulding Processes 8

Introduction to plastic moulding process, Thermoplastics and thermosetting plastics, Compression moulding, Transfer moulding, Injection moulding, Blow Moulding, Moulding faults, causes and remedies.

UNIT III Metal Forming and Joining Processes 10

Introduction to sheet metal process, Sheet metal forming process – Bending, Drawing, Blanking Coining, Embossing, Flanging, Rolling Processes - Sheet metal cutting process – Piercing, Trimming, Shaving process. Tubular forming and tubular cutting processes with applications, Types of dies, Defects in sheet metal forming process.

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Introduction to welding process, Nomenclature of weld bead, Classification of welding, Types of welding joints, symbols and Positions, Types of welding - SMAW, GMAW (MIG / MAG), SAW and TIG, Electric resistance welding process - Spot, seam and projection welding, Gas welding process, Soldering and Brazing, Defects of welding with causes and remedies.

UNIT IV Metal Cutting Process 10

Introduction to metal cutting processes, Cutting tool and its types, Types of Tool wear, Merchant's Circle, Lathe and its operations, Drilling machine – Types and operations, milling machine – Types and operations, Cutting fluids and its application.

UNIT V Metal Finishing Processes 7

Introduction to Metal Finishing Processes, Grinding process - Cylindrical grinding, Surface grinding, Centre less grinding, Grinding wheel specifications, Super finishing processes - Need and its types with applications, Lapping, Honing, Burnishing, Buffing and Sandblasting processes.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Explain various types of metal casting and forging processes.	Understand
CO2: Explain various types of Plastic Moulding Processes.	Understand
CO3: Explain various types of metal forming and joining processes.	Understand
CO4: Explain various types of metal cutting processes.	Understand
CO5: Explain various types of metal Finishing processes.	Understand

Text Book(s):

T1. Serope Kalpakjian, "Manufacturing engineering and Technology", 7th Edition, Pearson Publishers, 2018.

T2. Chapman, W.A.J., "Workshop Technology, Vol – II", 4th Edition, Oxford & IBH Publishing Co. Ltd., 2007.

T3. Choudhry, S.K.H., "Elements of Work Shop Technology, VoL II", 15th Edition Media Promoters & Publishers, 2010.

T4. Allen; W. S. and Baker; P. N., "Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding]", 1st Edition, CBS Publishers and Distributors, New Delhi, 2004.

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Reference Book(s):

R1.Production Technology by HMT, Tata McGraw Hill Education ,2017.

R2.Er.R.K.Rajput, “A Textbook of Manufacturing Technology (Manufacturing Process)”, 2nd Edition, Laxmi Publications, 2017.

R3. William F. Hosford & Robert M. Caddel, “Metal forming (Mechanics & Metallurgy)”, 4th Edition, Prentice Hall Publishing Co., 2014.

Web References:

1. http://www.efunda.com/home.cfm
2. https://www.magicmarks.in/
3. https://www.accessengineeringlibrary.com/front
4. https://nptel.ac.in/courses/112105127/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	2	2	-
CO2	2	1	-	-	-	-	-	1	-	1	-	2	2	-
CO3	2	1	-	-	-	-	-	1	-	1	-	2	2	-
CO4	2	1	-	-	-	-	-	1	-	1	-	2	2	-
CO5	2	1	-	-	-	-	-	1	-	1	-	2	2	-

High-3; Medium-2;Low-1

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Course Code: 19MECN3301	Course Title: COMPUTER AIDED MODELING AND DRAFTING LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Engineering Drawing

Course Objectives

The course is intended to:

1. Create a CAD model as per the given part/assembly drawing.

LIST OF EXPERIMENTS

1. Construction of 2D sketches using AutoCAD.
2. Construction of 2D sketches with dimensions using AutoCAD.
3. Construction of simple 3D models with basic features using a CAD tool.
4. Construction of 3D models with advanced features such as holes, pattern, swept, and etc. using a CAD tool.
5. Develop the part drawing of 3D models using a CAD tool.
6. Develop the production drawing of given machine component using a CAD tool.
7. Develop the assembly drawing of given machine component using a CAD tool.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Create a CAD model as per the given part/assembly drawing with appropriate dimensions and tolerance using appropriate template.	Apply

Text Book(s):

T1. Cencil Jensen, Jay D.Helsel and Dennis R. Short, " Engineering Drawing and Design", Tata McGraw Hill India, New Delhi, 7th Edition, 2017.

T2. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, Gujarat, 53rd edition, 2015.

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T3. K. V. Natrajan, “A Text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 48th edition, 2018.

Reference Book(s):

R1 Louis Gary Lamit, “PTC Creo Parametric 3.0”, Global engineering, Cengage learning, USA.

R2 John K.C., “Engineering Graphics”, PHI Learning, Delhi, 1st edition, 2009.

R3 Dhananjay A. Jolhe, “Engineering Drawing with an introduction to AutoCAD” Tata McGraw India, New Delhi, 3rd edition, 2008.

Web References:

1. https://en.wikipedia.org/wiki/Engineering_drawing

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	2	3	2	-	1	1	-

High-3; Medium-2; Low-1

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Course Code: 19MECN3302	Course Title: MANUFACTURING PROCESSES LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Make a cast component
2. Machine a given workpiece
3. Make a forged component
4. Make a sheet metal component

LIST OF EXPERIMENTS

1. Preparation of sand mould using single piece / double piece pattern
2. Forging of round rod to square rod
3. Forming of cup using hydraulic press
4. Exercise on Turning of Shaft
5. Exercise on Key Way Milling of Shaft
6. Exercise on Gear Milling / Gear Shaping
7. Exercise on Grinding of Cylindrical Shaft
8. Exercise on Key Way Slotting in Gear
9. Exercise on Surface Grinding
10. Exercise on Drilling and Tapping
11. Exercise on Machining a Bolt using Capstan & Turret lathe

Course Outcomes

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Make a cast component using single piece / double piece pattern for the given design requirement.	Apply
CO2: Machine the given work piece using lathe, milling and drilling based on given drawing.	Apply
CO3: Make a forged component by hand forging process for the given design requirement.	Apply
CO4: Make a sheet metal component by forming process for the given design requirement.	Apply

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO
CO1	3	2	2	2	1	-	-	2	3	2	-	1	2	-
CO2	3	2	2	2	1	-	-	2	3	2	-	1	2	-
CO3	3	2	2	2	1	-	-	2	3	2	-	1	2	-
CO4	3	2	2	2	1	-	-	2	3	2	-	1	2	-

High-3; Medium-2; Low-1

End of Semester III

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Semester IV

Course Code: 19MABG1401	**Course Title: PROBABILITY AND STATISTICS** (Common to EE,EC,AU,CS,ME,IT & CE)		
Course Category: Basic Science		**Course Level: Introductory**	
L:T:P (Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours:60**	**Max Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Calculate expectations and variances of random variables
2. Apply the concepts of standard distributions to solve practical problems
3. Calculate the correlation and regression for two variables
4. Test the samples based on hypothesis
5. Analyze the samples based on variance

Unit I Probability and Random Variables 9+3

Axioms of Probability- Conditional Probability- Total Probability -Baye's Theorem- Random Variables- Probability Mass Function- Probability Density Functions- Properties - Moments-Moment generating functions and their properties.

Unit II Standard Distributions 9+3

Binomial- Poisson- Uniform –Exponential- Normal Distributions and their properties-Functions of a random variable.

Unit III Two Dimensional Random Variables 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and regression – Transformation of random variables.

Unit IV Testing of Hypotheses 9+3

Sampling Distributions- Testing of hypotheses for mean, variance, proportions and differences using Normal, t, Chi-Square and F distributions – Tests for independence of attributes and Goodness of fit.

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UNIT V Design of Experiments 9+3

Analysis of Variance (ANOVA)- One way Classification – Completely Randomized Design(CRD) – Two way Classification – Randomized Block Design (RBD) – Latin square.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Calculate expectations and variances of random variables	Apply
CO2: Apply the concepts of standard distributions to solve practical problems	Apply
CO3: Calculate the correlation and regression for two variables	Apply
CO4: Test the samples based on hypothesis	Apply
CO5: Analyze the samples based on variance	Apply

Text Book(s):

T1. Veerajan T, "Probability, Statistics and Random process", 3rd Edition, Tata McGraw-Hill, New Delhi, 2017.

T2. Dr.J.Ravichandran, "Probability and Statistics for Engineers", 1st Edition, Wiley India Pvt.Ltd.,2010.

Reference Book(s):

R1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition Pearson Education, Asia, 2013.

R2. M.R. Spiegel, J. Schiller and R.A. Srinivasan, "Schaum's Outlines Probability and Statistics", 4th Edition Tata McGraw Hill edition, 2012.

R3. Morris DeGroot, Mark Schervish, "Probability and Statistics", Pearson Educational Ltd, 4th Edition, 2014.

Web References:

1. **https://onlinecourses.nptel.ac.in/111105041/**
2. **https://nptel.ac.in/downloads/111105041/**
3. **https://nptel.ac.in/courses/111105090/**

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	1	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	1	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Assessment Pattern:

<table>
<tr><td rowspan="6">Continuous Assessment</td><td>Assessment Component</td><td>CO .No.</td><td>Marks</td><td>Total</td></tr>
<tr><td>CCET 1</td><td>1,2</td><td>50</td><td rowspan="4">30</td></tr>
<tr><td>CCET 2</td><td>3,4</td><td>50</td></tr>
<tr><td>Retest</td><td>1,2,3,4</td><td>50</td></tr>
<tr><td>CCET 3</td><td>5</td><td>50</td></tr>
<tr><td>Tutorial / Quiz / Assignment</td><td>1,2,3,4,5</td><td>30</td><td>10</td></tr>
<tr><td>End Semester Examination</td><td>ESE</td><td>1,2,3,4,5</td><td>100</td><td>60</td></tr>
<tr><td colspan="4">Total</td><td>100</td></tr>
</table>

Course Code: 19MECC2401	**Course Title: STRENGTH OF MATERIALS** (Common to AU, ME & MC)		
Course Category: Professional Core		**Course Level: Practice**	
L:T:P(Hours/Week) 3: 0: 2	**Credits: 4**	**Total Contact Hours:75**	**Max Marks:100**

Pre-requisites

- Physics for Mechanical Sciences
- Engineering Mechanics

Course Objectives

The course is intended to:

1. Characterize materials and determine the axial stresses and strains developed
2. Calculate the principal stresses and planes for 2-D state of stress in bars and thin walled pressure vessels.
3. Compute the stress distribution and slope-deflection in beams.
4. Calculate the shear stress distribution in solid and hollow shafts and design helical springs and leaf springs.
5. Compute the diameter of shafts subjected to combined bending, twisting and axial loads.

Unit I Deformation of Solids 9

Mechanical properties of metals - Rigid and deformable bodies. Stress and Strain - tensile, compressive and shear, stress-strain diagram - Hooke's law - Factor of Safety - Poisson's ratio - relationship between elastic constants. Deformation of simple and compound bars under axial load. Strain energy - resilience, proof resilience and modulus of resilience - Strain energy due to axial load. Stresses due to gradual load, sudden load and impact load. Thermal stresses.

Unit II Bi-axial State of Stress 9

Biaxial state of stresses – Principal planes and stresses – Maximum shear stress and planes of maximum shear stress - Mohr’s circle for biaxial stresses. Stresses in thin walled pressure vessels.

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Unit III Flexure In Beams and Deflection of Beams 9

Theory of simple bending – Bending stress and Shear stress variation in beams of standard section like 'I', 'L' and 'T'.

Evaluation of beam deflection and slope for cantilever and simply supported beams- Macaulay and Moment-area methods.

Unit IV Torsion of Shafts and Springs 9

Theory of torsion and assumptions - torsion equation- polar moment of inertia and polar modulus - Shear stress distribution in solid and hollow circular shafts.

Helical compression springs - terminology, styles of end - stress and deflection equation. Multi-Leaf springs - terminology - stress and deflection equation - Nipping of leaf springs

Unit V Theories of failure 9

Introduction to theories of failure - Maximum Principal Stress theory - Maximum Principal Strain theory - Maximum Strain Energy Theory - Maximum Distortion Energy theory - Maximum Shear Stress theory. Stresses in circular shaft with combined bending, axial loading and torsion. Equivalent bending moment and equivalent twisting moment.

List of Experiments: 30

1. Conduct tensile test on Mild Steel rod.
2. Conduct shear test on Mild steel and Aluminum rods by Double shear.
3. Calculate the modulus of rigidity of mild steel rod by Torsion test.
4. Determine the toughness of the given mild steel specimen using IZOD and CHARPY impact test.
5. Determine the Hardness Number of metals by Brinell and Rockwell Hardness tester after the Heat Treatment.
6. Estimate the stiffness and modulus of rigidity of the helical spring by Compression test.

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Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Characterize materials and determine the axial stresses and strains developed due to mechanical and thermal effects	Apply
CO2: Calculate the principal stresses and planes for 2-D state of stress in bars and thin walled pressure vessels using analytical and graphical methods.	Apply
CO3: Compute the stress distribution and slope-deflection in beams subjected to static loads.	Apply
CO4: Calculate the shear stress distribution in solid and hollow shafts subject to pure torsion and design helical springs and leaf springs subject to compressive loads.	Apply
CO5: Compute the diameter of shafts subjected to combined bending, twisting and axial loads using various theories of failure.	Apply

Text Book(s):

T1. Hibbeller RC, "Mechanics of Materials", 9th Edition Prentice-Hall of India, New Delhi, 2013.

T2. James M Gere, "Mechanics of Materials", 9th Edition Cengage Learning, India, 2019.

Reference Book(s):

R1. Rattan SS "Strength of Materials" 3rd Edition Tata McGraw-Hill Education Pvt Ltd., New Delhi, 2017.

R2. Beer F. P. and Johnston R," Mechanics of Materials", 7th Edition McGraw-Hill Book Co, Third Edition, 2017.

R3. Egor P.Popov," Mechanics of Materials", 2nd Edition, Pearson Co, 2015.

Web References:

1. http://nptel.ac.in/courses/112107147/

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	3	1	-	2	-	-
CO2	3	2	1	1	-	-	-	1	3	1	-	2	-	-
CO3	3	2	1	1	-	-	-	1	3	1	-	2	-	-
CO4	3	2	1	1	-	-	-	1	3	1	-	2	-	-
CO5	3	2	1	1	-	-	-	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

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Course Code: 19MECN2401	Course Title: THEORY OF MACHINES		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 2: 1: 2	Credits:4	Total Contact Hours:75	Max Marks:100

Pre-requisites

- Physics for Mechanical Sciences
- Engineering Mechanics

Course Objectives

The course is intended to:

1. Calculate kinematic parameters of simple mechanisms.
2. Calculate static and dynamic forces for the given mechanism.
3. Calculate the balance masses required in revolving & reciprocating applications.
4. Calculate the kinematic parameters of spur gear and gear trains.
5. Analyze single degree of freedom free and forced vibration system.

Unit I Mechanism Analysis 6+3

Relative and absolute velocities and acceleration in linkages - Vector loop representation - position, velocity and acceleration analyses of four bar and slider crank mechanisms using graphical method. Instantaneous centres of rotation – Kennedy's theorem – procedure for locating instantaneous centres of four bar and slider crank mechanisms. Synthesis of four bar mechanisms.

Unit II Force analysis in mechanisms 6+3

Applied and constrained forces, Static equilibrium conditions of two and three force members, Problems in static force analysis of four bar mechanism. D'Alembert's principle, Dynamic force analysis in reciprocating engine- Gas forces, Bearing loads, Crank shaft Torque. Turning moment diagrams, Flywheels, Coefficient of fluctuation of Energy and speed, mass of flywheel required.

Unit III Balancing of rotating and reciprocating masses 6+3

Static and dynamic balancing - balancing of rotating masses - balancing of single rotating mass by a single mass in the same plane. Balancing of single rotating mass by two masses in different plane and balancing of several rotating masses in the same plane, balancing of several masses in different planes - balancing of reciprocating masses-balancing of primary and secondary

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unbalanced forces of reciprocating masses. Partial balancing in IC engines.

Unit IV Kinematics of spur gear and gear trains 6+3

Types of gears – spur gear terminology – law of gearing - conjugate profile – cycloidal and involute tooth profile – length of path of contact – length of arc of contact – contact ratio – interference – number of teeth on pinion to avoid interference.

Classification of gear trains – calculation of velocity ratio of simple, compound and epicyclic (tabular column method) gear trains.

Unit V Longitudinal vibrations 6+3

Types of vibrations – basic elements of vibrating system – Degrees of Freedom – free longitudinal vibration of Single Degree of Freedom (SDOF) system: governing equation and natural frequency using equilibrium method and energy method – equivalent springs and dampers – free damped vibration of SDOF system: governing equation – under damped, critical damped and over damped systems – damping ratio – logarithmic decrement – force damped vibration – magnification factor – vibration isolation and transmissibility.

List of Experiments: 30

1. Balancing of reciprocating masses and rotating masses.
2. Compound gear train.
3. i)Single degree of freedom system- spring mass system.
   ii) Vibration table.
4. Whirling of the shaft.
5. Torsional vibration - two rotor system.

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Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Calculate position, velocity and acceleration of four bar and slider crank mechanisms using algebraic method and graphical method.	Apply
CO2: Calculate the static and dynamic forces for equilibrium of the given a slider crank or a four bar mechanism.	Apply
CO3: Calculate the balance masses required and its location in revolving & reciprocating applications	Apply
CO4: Calculate the kinematic parameters of spur gear and velocity ratio of simple, compound and epicyclic gear trains.	Apply
CO5: Analyze single degree of freedom longitudinally vibrating systems for free and forced vibrations with undamped and damped conditions.	Apply

Text Book(s):

T1 S.S. Rattan, "Theory of Machines", McGraw Hill Education, 4th Edition. 2017.

T2 Norton, R.L., "Kinematics and Dynamics of Machinery", Tata McGrawHill Education Pvt. Ltd., New Delhi, SI Edition 2014.

Reference Book(s):

R1 Gordon R. Pennock & Joseph E. Shigley John J. Uicker, "Theory Of Machine And Mechanisms Si Edition", Oxford University Press, 4th Edition 2014.

R2 Sadhu Singh, "Theory of Machines: Kinematics and Dynamics", Pearson Education India; 3rd Edition 2011.

R3 R.S. Khurmi, J.K. Gupta, "Theory of Machines", S.Chand, 14th Edition. 2005.

Web References:

1. **https://nptel.ac.in/courses/112104121/**
2. **https://nptel.ac.in/courses/112101096/**

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO2	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

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Course Code: 19MECN1401	Course Title: MANUFACTURING TECHNOLOGY		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Pre-requisites:

- Physics for Mechanical Sciences
- Chemistry for Mechanical Sciences
- Engineering Practice Laboratory

Course Objectives:

The course is intended to:

1. Select appropriate manufacturing methods.
2. Understand the feasibility and economics.
3. Impart basic knowledge about the process planning.
4. Understand the concept of inspection procedure and corrective actions.
5. Explain advances in manufacturing technology.

UNIT I Selection of manufacturing processes 9

Physical, mechanical and metallurgical properties of parts produced by different manufacturing processes, Selection of manufacturing process based on size, geometry, process complexity, functionality of parts and types of loads acting on parts. Selection of tools, tool holding devices and work holding devices. Selection of manufacturing process for general engineering applications – Case studies.

UNIT II Economics in the manufacturing process 9

Inhouse manufacturing technology - Concept of Production volume, Delivery schedule. Cost and delivery time analysis- Cost calculation procedure for machining & welding process. Parameters and calculation of forces during forging processes. Calculation of cutting speed, feed, depth of cut, machining time and Material removal rate for machining operation. Parameters and calculation of forces during forming and rolling processes.

UNIT III Process Planning 9

Process planning, Factors affecting process planning, Role of process planning in the production cycle, Route sheet and operations sheet, Contents of a process planning sheet, Preparation of a process planning sheet, Assembly practice – Manufacturing and assembly, Selective assembly, Process planning in assembly, Handling and transportation of assembly.

UNIT IV Product Inspection Procedure and Corrective actions 9

Raw material Inspection procedure - Physical distortions (bending, twisting, scratch, surface corrosion). Chemical composition, Physical verification procedure - parts, sub assembly and assembly. Functional inspection - Testing procedure of sub-assembly with corrective action, Case studies on development of various new products based on the need of customer.

UNIT V Advances in Manufacturing Technology 9

Unconventional machining processes – Classification, Working principle of AWJM, EDM, LBM and application. Additive manufacturing - Classification, Working principle of SLS, SLA and FDM, Application with case studies. Introduction on MEMS,NEMS, Electronics manufacturing technology and IIoT.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Choose appropriate manufacturing methods for given parts based on part functions, applications, geometry, and materials.	Apply
CO2: Evaluate the manufacturing process based on feasibility and economics to achieve part specification.	Apply
CO3: Prepare process planning sheet for given parts.	Apply
CO4: Analyze the deviation on the parts and decide the corrective action.	Apply
CO5: Explain various advanced technologies for current manufacturing scenario	Understand

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Text Book(s):

T1. Serope Kalpakjian, "Manufacturing engineering and Technology", 7th Edition, Pearson Publishers, 2018.

T2. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", 7th edition, Wiley Publishers, 2019

T3. Rao P N, "Manufacturing Technology, Vol 2, Metal Cutting and Machine Tools", 2nd Edition, Tata McGraw Hill, New Delhi, 13th reprint 2012.

Reference Book(s):

R1. Kapil Gupta, "Advanced Manufacturing Technologies: Modern Machining, Advanced joining and sustainable Manufacturing" Springer Publisher, 2017.

R2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016

R3. Prasad R., "Surface Mount Technology – Principles and practice", 2nd Edition, Chapman and Hall, 1997,

Web References:

1. http://www.efunda.com/home.cfm
2. https://www.magicmarks.in/
3. https://www.accessengineeringlibrary.com/front
4. https://nptel.ac.in/courses/112105127/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	2	2	-
CO2	3	2	1	1	-	-	-	1	-	1	-	2	2	-
CO3	3	2	1	1	-	-	-	1	-	1	-	2	2	-
CO4	3	2	1	1	-	-	-	1	-	1	-	2	2	-
CO5	2	1	-	-	-	-	-	1	-	1	-	2	2	-

High-3; Medium-2; Low-1

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Course Code:19MECN3401	Course Title: MANUFACTURING TECHNOLOGY LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Manufacturing Processes Laboratory

Course Objectives

The course is intended to:

1. Develop a process plan for manufacturing of components.
2. Use various manufacturing process to complete the given components/assembly.

LIST OF EXPERIMENTS

1. Prepare a process plan for the selected product from the product bank.
2. Calculate different process parameters, forces and levels for manufacturing the component.
3. Manufacture the components of the product using various manufacturing processes.
4. Prepare an inspection sheet for the component.
5. Analyze the deviation and perform the corrective action.

Course Outcomes

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Develop a process plan to manufacture the components of selected product.	Apply
CO2:	Use Lathe, Drilling, Milling, Slotting and grinding machines to manufacture a component.	Apply

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	2	3	2	-	1	2	1
CO2	3	2	2	2	1	-	-	2	3	2	-	1	2	1

High-3; Medium-2; Low-1

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Course Code: 19PSHG6002	Course Title: UNIVERSAL HUMAN VALUES 2 :UNDERSTANDING HARMONY (Common to all B.E/B.Tech Programmes)		
Course Category: Humanities		Course Level: Practice	
L:T:P (Hours/Week) 2: 1: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Pre-requisites

- 19SHMG6101- Induction Program (UHV1)

Course Objectives

The course is intended to:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Strengthening of self-reflection
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Development of commitment and courage to act

Unit I Introduction to Value Education 6+3

Need for the Value Education;. Self -exploration as the process for value education ; Continuous Happiness and Prosperity: A look at basic Human Aspirations; Right understanding: Relationship and Physical Facilities ; Happiness and Prosperity: current scenario ; Method to fulfill the Basic human aspirations

Unit II Harmony in Human Being 6+3

Human being as a co-existence of self ('I') and the material 'Body'; needs of Self ('I') and 'Body'; The Body as an instrument of 'I' ; Harmony in the self('I'); Harmony of the self('I') with body ;Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya.

Unit III Harmony in the Family and Society 6+3

Harmony in the Family the basic unit of human interaction; Values in human to human relationship; Trust as the foundational values of relationship; Respect as the right evaluation ;Understanding harmony in the society (society being an extension of family); Vision for the universal human order

Unit IV Harmony in the Nature 6+3

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Understanding the harmony in the Nature Interconnectedness, self-regulation and mutual fulfillment among the four orders of nature; Existence as Co-existence at all levels; Holistic perception of harmony in existence.

Unit V Harmony on Professional Ethics 6+3

Natural acceptance of human values ;Definitiveness of Ethical Human Conduct; Basic for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics ;Case study: holistic technologies, management models and production systems ;Strategy for transition towards value based life and profession

Course Outcomes At the end of this course, students will be able to:	**Affective Level**
CO1. Reflect on values, aspiration, relationships and hence identify strengths and weaknesses.	Responding
CO2. Appraise physical, mental and social well being of self and practice techniques to promote well being.	Responding
CO3. Value human relationships in family and society and maintain harmonious relationships.	Valuing
CO4. Respect nature and its existence for survival and sustainable of all life forms and hence practice conservation of nature	Valuing
CO5. Appreciate ethical behaviour as a result of value system in personal and professional situations	Receiving

Text Book(s):

T1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Reference Book(s):

R1.Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

R2.Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

R3. The story of stuff, Annie Leonard, Free Press, New York 2010.

Web References:

- https://aktu.ac.in/hvpe/ResourceVideo.aspx

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- http://hvpenotes.blogspot.com/
- https://nptel.ac.in/courses/109/104/109104068/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	1	2	2	-	-	2
CO2	-	-	-	-	-	1	2	2	2	1	-	2
CO3	-	-	-	-	-	2	2	2	2	1	-	2
CO4	-	-	-	-	-	2	2	2	2	-	-	2
CO5	-	-	-	-	-	1	2	2	2	-	-	2

High-3; Medium-2; Low-1

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Course Code: 19MEPN6401	Course Title: MINI-PROJECT		
Course Category: Project		Course Level: Practice	
L:T:P (Hours/Week) 0: 0: 4	Credits: 2	Total Contact Hours:60	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Work collaboratively on a team to successfully complete a design project
3. Effectively communicate the results of projects in a written and oral format

The objective of Project I is to enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental committee.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Take up any challenging practical problems and find solution by formulating proper methodology.	Apply
CO2: Work collaboratively on a team to successfully complete a design project	Apply
CO3: Effectively communicate the results of projects in a written and oral format	Apply

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	-	-	-	3	3	2	1
CO2	-	-	3	-	-	-	-	3	3	-	3	3	2	1
CO3	-	-	-	-	-	-	-	3	-	3	-	3	2	1

High-3; Medium-2; Low-1

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Course Code: 19MEPN6001	Course Title: INTERNSHIP OR SKILL DEVELOPMENT		
Course Category: Project		Course Level: Practice	
L:T:P (Hours/Week) 2 Weeks	Credits: 1	Total Contact Hours: Nil	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Understand industry-specific terminology and practices
2. Solve simple industrial problems
3. Work collaboratively on a team
4. Effectively communicate the activities of internship in a written and oral format

Minimum of two weeks in an Industry in the area of Mechanical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Understand industry-specific terminology and practices	Apply
CO2: Solve simple industrial problems	Understand
CO3: Work collaboratively on a team	Apply
CO4: Effectively communicate the activities of internship in a written and oral format	Understand

End of Semester IV

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Semester V

Course Code: 19MECC1501	**Course Title: MECHANICAL DESIGN** (Common to MC & ME)		
Course Category: Professional Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours: 60**	**Max Marks:100**

Pre-requisites

- Strength of Materials

Course Objectives

The course is intended to:

1. Design the machine elements subjected to static loads.
2. Design the machine elements against fluctuating and impact loads.
3. Calculate the design parameters for power transmitting element.
4. Determine the design parameters of helical and leaf spring.
5. Design/Select a suitable bearing.

UNIT I DESIGN FOR STATIC LOAD OR STEADY STRESSES 9+3

Design Processes and its types, factor of safety - selection. Preferred numbers, Selection of materials and its properties, Fits and Tolerances - eccentric loading-stress due to eccentric loading, curved beams - problems.

UNIT II DESIGN FOR FLUCTUATING AND IMPACT LOADS 9+3

Fatigue, types, Endurance limit, modifying factors, relation between endurance limit, ultimate tensile strength and yield strength, problems on different fatigue loading conditions. Stress concentration, stress concentration factor, causes of stress concentration, method of reducing stress concentration, stress concentration factor for different material configuration. Notch sensitivity, factors affecting of notch sensitivity. Impact loading, shock loading, simple problems.

9+3

UNIT III DESIGN OF SHAFTS, KEYS, AND COUPLINGS

Difference between shaft, axle and spindle, Shaft materials, criteria of shaft design, different transmitting elements on a shaft, shaft design against static loading for given application.

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Shaft design for fatigue loading. Keys, types of keys, stresses developed in the key. Spline, stresses in spline shaft, design of shunk key and spline.

Couplings, types of coupling, design of coupling based on given speed and load conditions, Design of flexible coupling based on given speed and load conditions.

UNIT IV DESIGN OF SPRINGS 9+3

Springs, types of springs, applications, spring terminology. Stresses in helical springs, Design of helical and concentric spring for given loading. Leaf springs, NIP in leaf springs Design of leaf spring for given application.

UNIT V DESIGN OF BEARING 9+3

Bearings, bearing types, Parts of the bearing, rolling contact bearing, its applications. Load carrying capacity, equivalent load, Life of bearing, Load life relationship, Problems. Selection of ball bearings from manufacturing catalogue. Sliding contact bearings, types and Nomenclature. Hydrodynamic bearing, load carrying capacity, lubrication, selection of lubricant, equivalent load, minimum oil film thickness- length to diameter ratio- bearing pressure, radial clearance. Mckees equation, Somerfield equations - Bearing characteristic number problems.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design the machine selements subjected to simple and combined static loads.	Apply
CO2: Design the machine elements against fluctuating loads and impact loads.	Apply
CO3: Calculate the design parameters for power transmitting element such as shaft, key, and coupling.	Apply
CO4: Determine the design parameters of helical and leaf spring for given application.	Apply
CO5: Design/Select a suitable bearing for the given application.	Apply

Text Book(s):

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T1. V.B. Bhandari. “Design of Machine Elements” Tata McGraw Hills Education, 5th edition, 2020.

T2. Shigley J.E and Mischke C.R., “Mechanical Engineering Design”, Sixth Edition, Tata McGraw Hill, 2012.

Reference Book(s):

R1. P. C Sharma and A. K Agarwal. “Machine Design” (SI units). S.K. Kataria& Sons, Reprint 2013.

R2. Ugural A.C, “Mechanical Design – An Integral Approach”, McGraw-Hill Book Co., 2010.

R3. Spotts M.F., Shoup T.E “Design and Machine Elements” Pearson Education, 2012

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO2	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	-	1	-	2	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td>Course Code: 19MECN2501</td><td colspan="3">Course Title: APPLIED THERMODYNAMICS</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 2</td><td>Credits:4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Prerequisites

- Fluid Mechanics and Hydraulic Machinery
- Physics for Mechanical Sciences

Course Objectives

The course is intended to:

1. Evaluate the thermodynamic characteristics of IC engines.
2. Calculate the performance characteristics of steam boiler and condenser.
3. Analyze the performance characteristics of steam nozzles and steam turbines.
4. Evaluate the performance characteristics of air compressors.
5. Calculate the performance of refrigeration and air-conditioning systems.

UNIT I GAS POWER CYCLESAND PERFORMANCE OF IC ENGINES 9

Air standard cycles- Otto, Diesel, Dual, Brayton cycles. Calculation of mean effective pressure and air standard efficiency. Engine tests - performance, heat balance, retardation and Morse test.

UNIT II STEAM BOILERS AND CONDENSERS 9

Steam boilers- Definition, Types – Fire tube and water tube, Mountings and Accessories, performance calculations, Indian Boilers Regulation (IBR) Act, Energy conservation opportunities in boiler. Steam condensers-Functions, elements of a condensing plant, types, estimation of cooling water requirement, condenser efficiency.

UNIT III STEAM NOZZLES AND TURBINES 9

Steam nozzles- flow through steam nozzles, effect of friction, critical pressure ratio and super saturated flow, nozzle design calculations. Steam turbines- impulse and reaction turbines, compounding, velocity diagram, governing of turbines.

UNIT IV AIR COMPRESSORS 9

Introduction to air-compressors - Reciprocating air compressor, performance characteristics, effect of clearance volume, free air delivery and displacement, intercooler, after cooler - Rotary compressor - vane type, centrifugal and axial, flow performance characteristics, Application of various types of compressors.

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UNIT V REFRIGERATION AND AIR CONDITIONING 9

Fundamentals of refrigeration – COP - vapour compression refrigeration system - cycle, p-h chart, vapour absorption system- comparison, properties of refrigerants, performance calculations.

Fundamentals of air conditioning system, simple cooling and heat load estimation. Air-conditioners -window, split, summer and winter, centralized air-conditioning systems.

List of Experiments 30

1. Valve timing and Port timing diagrams.
2. Performance test on single cylinder, 4-stroke diesel engine.
3. Performance test on centrifugal air blower.
4. Performance test on two stage reciprocating air compressor.
5. Determination of COP of refrigeration system.
6. Determination of viscosity of lubricating oil using Redwood viscometer.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Evaluate the thermodynamic characteristics of IC engines using air-standard cycles.	Apply
CO2: Calculate the performance characteristics of steam boiler and condenser.	Apply
CO3: Analyze the performance characteristics of steam nozzles and impulse, reaction steam turbines using velocity diagrams.	Apply
CO4: Evaluate the performance characteristics of reciprocating and rotary air compressors.	Apply
CO5: Calculate the performance of refrigeration and air-conditioning systems using psychrometric chart.	Apply

Text Book(s):

T1. Kothandaraman C.P, Domkundwar and A.V. Domkundwar, “A Course in Thermal Engineering”, Dhanpat Rai & Sons, 5^{th} edition, 2016.

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T2. Rajput R.K. "Thermal Engineering", Laxmi Publications (P) Ltd., New Delhi, 10th edition, 2018.

Reference Book(s):

R1. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, 3rd edition, 2013.

R2. Arora C.P., "Refrigeration and Air conditioning", Tata McGraw-Hill, New Delhi, 2005.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO2	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

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Course Code: 19MECN2502	**Course Title: ELECTRICAL AND ELECTRONICS ENGINEERING**		
Course Category: Professional Core		**Course Level: Practice**	
L:T:P (Hours/Week) 3: 0: 2	**Credits: 4**	**Total Contact Hours: 75**	**Max Marks:100**

Prerequisites

- Nil

Course Objectives

The course is intended to:

1. Explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.
2. Explain the fundamentals of semiconductor and applications.
3. Explain the principles of digital electronics.
4. Impart knowledge of communication.
5. Explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.

UNIT I ELECTRICAL CIRCUITS & MEASURMENTS 9

Fundamental laws of electric circuits- Steady State Solution of DC Circuits - Introduction to AC Circuits -Sinusoidal steady state analysis- Power and Power factor - Single Phase and Three Phase Balanced Circuits. Classification ion of instruments - Operating Principles of indicating Instruments

UNIT II ELECTRICAL MACHINES 9

Construction, Working Principle and applications of DC Machines, Transformers, Single phase and Three-phase Induction motors, Special Machines-Stepper motor, Servo Motor and BLDC motor.

UNIT III SEM ICONDUCTOR DEVICES AND APPLICATIONS 9

Introduction - Characteristics of PN Junction Diode - Zener Effect - Zener Diode and its Characteristics - Half wave and Full wave Rectifiers - Voltage Regulation.

Bipolar Junction Transistor - CB, CE, CC Configurations and Characteristics - Elementary Treatment of Small Signal Amplifier.

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UNIT IV DIGITAL ELECTRONICS **9** Binary Number System - Boolean Algebra theorems- Digital circuits - Introduction to sequential Circuits- Flip-Flops - Registers and Counters - AID and D/A Conversion -digital processing architecture.

UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING **9**

Introduction - Elements of Communication Systems- Modulation and Demodulation: Principles of Amplitude and Frequency Modulations. Digital Communication - Communication Systems: Radio, Antenna,TV, Fax,ISDN, Microwave,Satellite and Optical Fibre (Block Diagram Approach only).

List of Experiments **30**

1. Conduct load test on DC shunt motor and draw the speed-torque characteristics.
2. Verify the working of half-wave rectifier and draw the waveforms.
3. Draw the VI characteristics of PN Junction diode.
4. Verify the working of basic logic gates.
5. Verify the truth table of D and T flipflops.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Able to identify the electrical components and circuits.	Understand
CO2: Able to explain the characteristics of electrical machines.	Understand
CO3: Identify electronics components and understand their characteristics.	Understand
CO4: Explain the principles and functions of digital electronic components.	Understand
CO5: Explain the functions of elements in communication systems.	Understand

Text Book(s):

T1. D P Kothari and l.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, 4th edition 2019.

T2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson India, 2017.

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Reference Book(s):

R1. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education(India) Private Limited, 2009.

R2. Del Toro, "Electrical Engineering Fundamentals",Pearson Education, New Delhi, 2007.

R3. Leonard S Bobrow, “Foundations of Electrical Engineering", Oxford University Press, 2013.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td>Course Code: 19MECC2501</td><td colspan="3">Course Title: PROBLEM SOLVING USING PYTHON FOR MECHANICAL SCIENCES
(Common to AU, MC & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P (Hours/Week) 2: 0: 2</td><td>Credits:3</td><td>Total Contact Hours:60</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Develop algorithmic solutions to simple computational problems Read, write, execute by hand simple Python programs.
2. Structure simple Python programs for solving problems.
3. Decompose a Python program into functions.
4. Represent compound data using Python lists, tuples, dictionaries.
5. Read and write data from/to files in Python Programs.

UNIT I ALGORITHMIC PROBLEM SOLVING 6

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list.

UNIT II DATA, EXPRESSIONS, STATEMENTS 6

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments.

UNIT III CONTROL FLOW, FUNCTIONS 6

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation.

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UNIT IV LISTS, TUPLES, DICTIONARIES 6

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension; Illustrative programs: selection sort, histogram.

UNIT V FILES, MODULES, PACKAGES 6

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.

List of Experiments 30

1. Program to calculate the linear stress, strain, Young's modulus & other elastic moduli and strain energy of the bar of user specified dimensions and load.
2. Program to calculate the Thermal efficiency of Otto Engine & COP of the heat engine for the user specified inputs.
3. Program to calculate the diameter of the shaft for the user specified inputs.
4. Program to find the dimensions of a Flexible Flange Coupling.
5. Program to plot the equation of the motion of a simple pendulum.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Develop algorithmic solutions to simple computational problems Read, write, execute by hand simple Python programs.	Understand
CO2: Structure simple Python programs for solving problems.	Apply
CO3: Decompose a Python program into functions.	Understand
CO4: Represent compound data using Python lists, tuples, dictionaries.	Understand
CO5: Read and write data from/to files in Python Programs.	Understand

Text Book(s):

T1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/).

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T2. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

Reference Book(s):

R1. John V Guttag, —Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013.

R2. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	1	1	1	3	1	-	2	-	-
CO2	3	2	1	1	1	1	1	1	3	1	-	2	-	-
CO3	2	1	-	-	1	1	1	1	3	1	-	2	-	-
CO4	2	1	-	-	1	1	1	1	3	1	-	2	-	-
CO5	2	1	-	-	1	1	1	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

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Course Code: 19MECN3501	Course Title: COMPUTER AIDED MACHINE DRAWING LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 3	Credits:1.5	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Engineering Drawing

Course Objectives

The course is intended to

1. Develop part models.
2. Prepare assembly drawings.

List of Experiments

1. Preparation of Knuckle joint part drawing.
2. Preparation of Flange coupling part drawing.
3. Preparation of Plummer Block part drawing.
4. Preparation of Screw Jack part drawing.
5. Preparation of Piston and Connecting rod part drawing.
6. Preparation of Knuckle joint assembly drawing .
7. Preparation of Flange coupling assembly drawing.
8. Preparation of Plummer block assembly drawing.
9. Preparation of Screw Jack assembly drawing .
10. Preparation of Piston and Connecting rod assembly drawing .

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop part models of machine components as per the design specification to prepare the assembly.	Apply
CO2: Prepare assembly drawings of machine components to disseminate how the parts fit together.	Apply

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Reference Book(s):

R1. Gopalakrishna, K. R., “Machine Drawing”, Subhas Publishing House, 20th Edition, 2017.

R2. Cecil Jensen, Jay D. Helsel, Dennis R. Short , “Engineering Drawing & Design”, McGraw-Hill Higher Education, 7th edition, 2007.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	2	3	2	-	1	2	-
CO2	3	2	2	2	2	-	-	2	3	2	-	1	2	-

High-3; Medium-2; Low-1

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<table>
<tr><td rowspan="2">**Course Code: 19PSHG6501**</td><td colspan="3">**Course Title: EMPLOYABILITY SKILLS 1 : TEAMNESS AND INTERPERSONAL SKILLS**
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr></tr>
<tr><td colspan="2">**Course Category: Humanities**</td><td colspan="2">**Course Level: Practice**</td></tr>
<tr><td>**L:T:P: 0: 0: 2**</td><td>**Credits:1**</td><td>**Total Contact Hours: 30**</td><td>**Max Marks:100**</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to

1. Enrich effective communicative attributes as part of the skills and Facilitate presentation and public speaking skills .
2. Handle negativities and explore the true self.
3. Inculcate interpersonal skills and to groom as a professional.
4. Educate the importance of Nonverbal skill set to attain perfection.
5. Provide teamness and its ethics to facilitate corporate working.

UNIT I EFFECTIVE COMMUNICATION & PRESENTATION SKILLS 6

Barriers of Communication – Fear of English – Handling Social Factors – Handling Psychological Factors – Handling Practical Problems – Do's & Don'ts– Effective Presentation – Presentation – Importance of Presentation – Slide orientation – Introduction in a presentation – Styles of a slide – Slide Templates – Font, color, Background – Graph Diagrammatic representation – Delivery of presentation – Body Language &Gestures – Verbal Attributes – Communication – Handling stammers and breaks – Handling fear of stage – Maintaining Confidence – Content delivery methods – Do's and Don'ts in a presentation– Tips to handle it– Effective Conclusion.

UNIT II : POSITIVE ATTTITUDE & HANDLING REJECTIONS 6

A,B,C's of Attitude – Influencing Factors – Individual Factors – Character Comparison – Strategies to Handle ourselves– Benefits of Positive Attitude – Do's& Don'ts – Handling Rejections– Identifying Negativities – How to handle it ??– Necessary changes – To do List – Creating One's self – Self Qualifiers.

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UNIT III INTERPERSONAL SKILLS 6

Life skills – Core IP Skills – Importance of IP Skills – Tips to improve IP Skills– Necessity of IP Skills.

UNIT IV BODY LANGUAGE, DRESSING & GROOMING 6

Unconscious Physical moments – Metrics of Body Language – Good Posture – Head Motion – Facial Expression – Eye contact – Gestures – Dressing – Grooming & Outlook – Necessity of good Body Language.

UNIT V TEAM ETHICS 6

Team Ethics – Necessity of Team Work – Teams Everywhere – Benefits of team culture – Reason for team failure – Conflicts – Handling Conflicts – Being a team player – Work difference from college.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Enriches effective communicative attributes as part of their skills and Facilitates with Presentation & Public speaking skills.	Apply
CO2: Be aware of negativities and handle them to explore the true self.	Apply
CO3: Enables them with necessity of Interpersonal skills to groom as a professional.	Apply
CO4: Educates them about importance of Nonverbal skill set to attain perfection.	Understand
CO5: Provides them with teamness and its ethics as it is the core of corporate working.	Apply

Text Books

T1. John C Maxwell, " The 17 Indisputable Laws of Teamwork: Embrace Them and Empower Your Team", Harper Collins Leadership Publishers, 2013.

Reference Books

R1. Patrick Lencioni, "The Five Dysfunctions of a Team: A Leadership Fable" Jossey Bass Publishers, 2006.

R2. Malcolm Gladwell, "Talking to Strangers: What We Should Know about the People We Don’t Know" Penguin Publishers, 2019.

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R3. Harvey Segler, " Body Language: Discovering & Understanding the Psychological secrets behind reading & Benefiting from Body Language" Kindle Edition, 2016.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO2	-	-	-	-	-	-	-	-	2	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	2	-	1	1	-	-
CO4	-	-	-	-	-	-	-	-	-	1	-	1	-	-
CO5	-	-	-	-	-	-	-	2	1	-	-	1	-	-

High-3; Medium-2; Low-1

End of semester V

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Semester VI

Course Code: 19MECC1601	Course Title: FINITE ELEMENT ANALYSIS (Common to AU & ME)		
Course Category: Professional Core		Course Level: Mastery	
L:T:P(Hours/Week) 3: 1: 0	Credits:4	Total Contact Hours:60	Max Marks:100

Pre-requisites

- Fluid Mechanics and Hydraulic Machinery
- Strength of Materials

Course Objectives

The course is intended to:

1. Convert physical problems into mathematical model.
2. Solve the one dimensional structural problems.
3. Solve the 2D vector variable problems .
4. Solve the 1D and 2D scalar variable problems.
5. Determine the shape function, Jacobean matrix, element stiffness matrix for 2D Quadrilateral element.

UNIT I FINITE ELEMENT FORMULATION 9+3

Finite element methods - general applicability of the methods, general finite element procedure, discretization of the domain, degree of freedom, basic element shapes and nodes, numbering of element and nodes, displacement models, local, global coordinates, Spring element - derivation of element stiffness matrices, global stiffness matrix and force vector using minimum potential energy principle, incorporation of boundary conditions and convergence criteria, solution of numerical problems.

UNIT II ONE DIMENSIONAL VECTOR VARIABLE PROBLEMS 9+3

Finite element modeling – Natural Coordinates and shape functions - linear bar element, - total potential energy approach - element stiffness matrix and force vector – global stiffness matrix and force vector - boundary condition – problems- quadratic element, Plane Trusses - development of shape function - element equations , element stiffness matrix and force vector – global stiffness matrix and force vector – boundary condition- problems, beam element –finite element formulation – Load vector –boundary condition- problems.

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UNIT III TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS USING CONSTANT STRAIN TRIANGLES 9+3

Finite element modeling – constant strain triangular element – Iso-parametric representation – Potential Energy approach - Element stiffness matrix and force vector – global stiffness matrix and force vector –Boundary condition – Problems, Axisymmetric solids subjected to Axisymmetric loading - axis symmetric formulation - Element stiffness matrix and force vector – global stiffness matrix and force vector –Boundary condition – Problems.

UNIT IV HEAT TRANSFER / SCALAR VARIABLE PROBLEM 1 D & 2D 9+3

Scalar variable problems- steady state heat transfer- 1D,2D conduction & convection – Global stiffness matrix and global thermal load vector - Boundary condition – Problems.

UNIT V TWO DIMENSIONAL VECTOR VARIABLE PROBLEM USING QUADRILATERAL ELEMENTS 9+3

Iso parametric elements – the four node quadrilateral- derivation of shape function, element stiffness matrix, element force vector- global stiffness matrix and force vector- Boundary condition- problems, element quality.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Convert physical problems into mathematical model using finite element procedure and solve simple problem using spring element	Apply
CO2: Solve the one dimensional structural problems such as bar, truss and beam using natural co ordinate system.	Apply
CO3: Solve the 2D vector variable problems by applying plane stress, strain and axi-symmetric conditions using CST element.	Apply
CO4: Solve the 1D and 2D scalar variable problems such as conduction and convection.	Apply
CO5: Determine the shape function, Jacobean matrix, and element stiffness matrix for 2D Quadrilateral element and find out the coordinates of a point in a element by applying interpolation technique.	Apply

Text Book(s):

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T1. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", Prentice-Hall of India, 4th Edition, Eastern Economy Editions, 2012.

T2. Logan D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd, 6th Edition. 2016.

Reference Book(s):

R1. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition, 2005.

R2. J.N.Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International Editions (Engineering Mechanics Series), 2005.

Web References:

1. http://textofvideo.nptel.iitm.ac.in/105106051/lec1.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO2	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	-	1	-	2	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td>Course Code: 19MECN2601</td><td colspan="3">Course Title: HEAT AND MASS TRANSFER</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week) 2: 1: 2</td><td>Credits:4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Physics for Mechanical Sciences
- Fluid Mechanics & Machinery
- Applied Thermodynamics

Course Objective

The course is intended to

1. Solve one dimensional steady state conduction heat problems.
2. Solve forced and natural convection heat transfer for fluid flows.
3. Design a heat exchanger using LMTD and NTU methods.
4. Calculate radiation heat transfer between different sections
5. Solve diffusion mass transfer through plane membrane.
6. Describe the different applications of heat transfer.

UNIT I ONE DIMENSIONAL STEADY STATE CONDUCTION 6+3

Basic concepts-Modes of heat transfer – Conduction, Convection and Radiation-Cartesian coordinate- Simple geometries-Plane wall, Cylinder, Sphere, Composite wall , cylinder and Sphere – simple problems.

Fins – Short fin end insulated, Short fin end not insulated and long fin – Simple problems. Internal heat generation – Plane wall and cylinder – Simple problems. One dimensional Unsteady state heat conduction (Qualitative treatment only)

UNIT II CONVECTION 6+3

Basics – dimensionless numbers, boundary layer concepts- external flow – flow over plates, cylinders and spheres – bank of tubes – Simple problems, internal flow – flow through cylinders – simple problems.

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Free convection – flow over horizontal plate, flow over vertical plate and flow through cylinders and spheres – simple problems.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 6+3

Phase change heat transfer – boiling- pool and flow boiling - condensation – simple problems.

Heat exchangers – Classifications - parallel flow, counter flow and cross flow- LMTD and NTU methods –simple problems.

UNIT IV RADIATION 6+3

Basic concepts – absorptivity, reflectivity and transmissivity – black body and grey body concepts – Laws of radiation – Stefan Boltzmann law, Kirchoff's law, Planck's law, Wien's law and Lambert's cosine law – shape factor algebra – between plates
and discs – simple problems, Radiation shield – single and 'n' number of shields – simple problems.

UNIT V DIFFUSION MASS TRANSFER AND HEAT TRANSFER APPLICATIONS 6+3

Basic concepts – properties of mixtures – mass concentration and mass fraction – mole concentration and mole fraction – diffusion mass transfer – Fick's law of diffusion – diffusion through plane membrane- simple problems.

Applications of heat transfer – domestic applications – Refrigerator, Air conditioning, process industrial applications- Food industry, Sugar Industry and automotive applications – Engine, radiators.

NOTE: (Use of Steam table & Heat & Mass Transfer Datebook are permitted)

List of Experiments 30

1. Thermal conductivity measurement for composite wall.
2. Thermal conductivity measurement of pipe insulation using lagged pipe approach.
3. Thermal conductivity measurement of insulating powder using concentric sphere.
4. Determination of heat transfer coefficient under natural convection and forced convection.
5. . Determination of Stefan Boltzman constant.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Solve one dimensional steady state heat conduction problems in simple geometries and fins with and without internal heat generation.	Apply
CO2: Solve forced and natural convection heat transfer problems for external and internal fluid flows in simple geometries.	Apply
CO3: Design a heat exchanger using LMTD and NTU methods with and without phase change.	Apply
CO4: Calculate radiation heat transfer between different geometries using shape factor concept.	Apply
CO5: Solve diffusion mass transfer through plane membrane.	Apply
CO6: Describe the different applications of heat transfer.	Apply

Text Book(s):

T1. Kothandaraman C.P “Fundamentals of Heat and Mass Transfer” New Age International, New Delhi, 2012.

T2. Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer” New Age International, 2017.

Reference Book(s):

R1. Yadav R “Heat and Mass Transfer” Central Publishing House, 1995.

R2. Nag P.K, “ Heat Transfer”, Tata McGraw-Hill, New Delhi, 2011.

R3. Ozisik M.N, “Heat Transfer”, McGraw-Hill Book Co., 1994.

Web References:

1. http://nptel.ac.in/courses/112101097/
2. http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Heat%20and%20Mass%20Transfer/New_index1.html

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO2	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td>Course Code: 19MECC1602</td><td colspan="3">Course Title: DATA SCIENCE FOR ENGINEERS
(Common to AU, MC & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Problem solving using PYTHON

Course Objective

The course is intended to

1. Understand the importance of data science and Python in Engineering.
2. Develop algorithmic solutions to simple computational problems.
3. Apply basic statistic tools and techniques.
4. Perform data analytics process using python.
5. Analyze relevant data using basic statistic tools and techniques.

UNIT I INTRODUCTION TO DATA SCIENCE AND PYTHON 9

Data, types of data, data sets, data frames, Importance of data applications, Introduction to data science, data science in various fields, anaconda, IDE, Jupyter Notebooks, Microsoft visual studio code, Python-Introduction, Application and Installation procedures. Creation of root path, conda activation, Import sample excel sheet and access using Jupyter Note book. Keys steps of the data analysis process.

UNIT II BASICS OF PYTHON PROGRAMMING 9

Ipython, Introduction to NumPy, NumPy Basics: Arrays and Vectorized Computation, Getting started with Pandas, data manipulation with pandas, Perform the entire data analysis process on a dataset, Visualization with Matplotlib, Learn to use NumPy and Pandas to wrangle, explore, analyze, and visualize data.

UNIT III ROLE OF STATISTICS AND PROBABILITY IN DATA SCIENCE 9

Central tendency and dispersion, Introduction to probability, Probability distributions, Random variables and expectation, sampling and sampling distribution, Distribution of Sample Means, population, and variance, confidence interval estimation, Hypothesis and Hypothesis testing, Errors, Two sample T test, F test, ANOVA, Pearson correlation, Goodness of Fit, Simple Linear, Multiple and Logistic Regression.

UNIT IV DATA ANALYTICS USING PYTHON 9

Data Loading, Storage, and File Formats, Data Cleaning and Preparation, Data Wrangling, Gathering Data, Assessing Data, Cleaning Data, Join, Combine, and Reshape, Plotting and Visualization, Data Aggregation and Group Operations, Data assembly and Missing data handling, Time Series, Machine Learning.

UNIT V DATA ANALYSIS PROCESS 9

Linear Algebra for Data Science, Introduction to Vectors and Matrices using Python, Python demo for distributions and statistics analysis using python, use Seaborn for statistical plots, Use SciKit-Learn for Machine Learning Tasks, Data Visualization in Data Analysis and Data Presentation.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Understand the importance of data science and Python in Engineering.	Understand
CO2: Develop algorithmic solutions to simple computational problems	Understand
CO3: Apply basic statistic tools and techniques	Understand
CO4: Perform data analytics process using python	Understand
CO5: Analyze relevant data using basic statistic tools and techniques	Understand

Text Book(s):

T1. Jake VanderPlas “Python Data Science Handbook: Essential Tools for Working with Data” O'Reilly Media, Inc, 1st edition, 2017.

T2. Daniel Y. Chen, (2018) “Pandas for Everyone: Python Data Analysis” Pearson Education, 1st edition, 2018.

T3. McKinney, W. “Python for data analysis: Data wrangling with Pandas, NumPy, and IPython” O'Reilly Media,2017.

T4. Douglas C. Montgomery, George C. Runger “Applied Statistics & Probability for Engineering” John Wiley & Sons, 6th edition, 2016.

T5. Jay L. Devore, “Probability and Statistics for Engineering and the Sciences”, Cengage Learning, 9th edition, 2020.

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Reference(s):

R1. Swaroop, C. H. “A Byte of Python” Python Tutorial, 2003.

R2. Anirban Das Gupta “Probability for Statistics and Machine Learning” Springer link, 2011.

R3. Anderson Sweeney Williams “ Statistics for Business and Economics, Cengage Learning, 2011.

Web References:

1. https://jakevdp.github.io/PythonDataScienceHandbook/index.html
2. https://towardsdatascience.com/
3. https://www.practicaldatascience.org/html/pandas_dataframes.html
4. https://hadrienj.github.io

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO
CO1	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	1	-	-	1	-	1	-	1	-	-

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">**Course Code: 19PSHG6601**</td><td colspan="3">**Course Title: EMPLOYABILITY SKILLS 2 : Campus To Corporate**
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">**Course Category: Humanities**</td><td colspan="2">**Course Level: Practice**</td></tr>
<tr><td>**L:T:P: 0: 0: 2**</td><td colspan="2">**Credits:1**</td><td>**Total Contact Hours: 30**</td><td>**Max Marks:100**</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to

1. Understand emotions and necessity to handle it to evolve as an effective social animal.
2. Build effective resumes to project the positives to be employable.
3. Facilitate working in a collaborative work environment and to engage in healthy agreements for building person's professional facet .
4. Enlighten the growth attribute to outperform, initiate and grow in professional arena.
5. Practice effective handling of time and discarding the unprofessional habits.

UNIT I EMOTIONAL INTELLIGENCE 6

Nature of Emotions – Importance of EI – EQ vs IQ – Behavioral difference between EQ & IQ – Acquiring Emotional Intelligence – Benefits of high EI – Steps to develop EI – Role of EI in Interviews.

UNIT II RESUME PREPARATION 6

Importance of Resume – Good Resume – Planning Resume – Organizing Resume – Spell check – Benefits of good resume – Resume Writing.

UNIT III GROUP DISCUSSION 6

Purpose of GD – Prerequisites of GD– Benefits of GD– Features of GD– Do's &Don'ts in GD– Accept Criticism &Feedback– Accepting Suggestions– GD Phrases– Effective Introduction & Conclusion – Preferred Etiquette of GD.

UNIT IV INTERVIEW ETIQUETTE(NETIQUETTE) 6

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Definition of Interview– Types of Interview – Prior interview– Know the Company – Employer's perspective in interview– Non Verbal etiquette– Dressing – Verbal Communication in Interview– Facing Rejection in Interview– Do's & Don'ts in an Interview– Common Interview Questions – Handling Stress Questions – Handling Telephonic Interviews.

UNIT V LEADERSHIP SKILLS& TIME MANAGEMENT 6

Leadership – Leadership Traits – Leadership styles – Types of Leaders – Qualities of a leader – Developing Perspectives

Time Management – Necessity of Time Management – Types of time – Estimation of time – Process of Time management – Efficient utilization of Time – Time wasting culprits – Tips to manage time – Goal setting in Time Management

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Enables them to understand the emotions and necessity to handle it to evolve as an effective social animal.	Understand
CO2: Effective resumes to project the positives to be employable.	Understand
CO3: Facilitates for a collaborative work environment and to engage in healthy agreements for building person's professional facet.	Understand
CO4: Enlightens the growth attribute to outperform, initiate and grow in professional arena.	Understand
CO5: Practices effective handling of time and discarding the unprofessional habits.	Understand

Text Book(s):

T1. Thea Kelley, "Get That Job! The Quick and Complete Guide to a Winning Interview " Plover crest Press, 2017.

Reference Book(s):

R1. Daniel Goleman, " Emotional Intelligence Reader's Guide", BANTAM PUBLISHERS, 1997.

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R2. Daniel Goleman, Richard Boyatzis & Annie McKee, " Primal Leadership: Unleashing the Power of Emotional Intelligence" Harvard Business Review Press; Anniversary edition, 2013.

R3. Stephen R Covey, " The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change" Simon & Schuster; Anniversary edition, 2013.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	1	-	1	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	1	-	-
CO3	-	-	-	-	-	-	-	-	1	1	-	1	-	-
CO4	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO5	-	-	-	-	-	-	-	1	-	-	1	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEPN6601	Course Title: INNOVATIVE AND CREATIVE PROJECT		
Course Category: Project		**Course Level: Practice**	
L:T:P (Hours/Week) 0: 0: 4	**Credits:2**	**Total Contact Hours:60**	**Max. Marks:100**

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Work collaboratively on a team to successfully complete a design project.
3. Effectively communicate the results of projects in a written and oral format.

The objective of Project I is to enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental committee.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Take up any challenging practical problems and find solution by formulating proper methodology.	Apply
CO2: Work collaboratively on a team to successfully complete a design project.	Apply
CO3: Effectively communicate the results of projects in a written and oral format.	Apply

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO
CO1	3	3	3	3	3	3	3	-	-	-	3	3	-	-
CO2	-	-	-	-	-	-	-	3	3	-	3	3	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	3	-	-

High-3; Medium-2; Low-1

End of semester VI

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Semester VII

Course Code: 19MECN1701	**Course Title: MECHATRONICS**		
Course Category: Professional Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks:100**

Prerequisites

The student should have undergone the courses:

- Electrical and Electronics Engineering

Course Objective

The course is intended to

1. Explain the fundamentals of mechatronics systems
2. Select sensors for various measurements
3. Write logic programs
4. Design Virtual Instruments for signal acquisition
5. Explain the application of mechatronics systems

UNIT I INTRODUCTION 9

Introduction to Mechatronics- Systems- Concepts of Mechatronics approach-Need for Mechatronics- Emerging area of Mechatronics- Classification of Mechatronics - Control system- Open Loop and Feedback Control –PID Control.

UNIT II SENSORS AND SIGNAL CONDITIONING 9

Introduction – Performance Terminology- Potentiometers-LVDT- Capacitance sensors- Strain gauges- Eddy current sensor-Hall effect sensor- Temperature sensors-Pressure sensors-Flow sensors- Light sensors- Selection of sensors- Signal processing.

UNIT III PROGRAMMABLE LOGIC CONTROLLERS 9

Introduction- Basic structure- Input and output processing- PLC Programming - Timers, Counters and internal relays- Data handling and manipulation – subroutine – Master control reset- Selection of PLC, HMI

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UNIT IV SYTEM DESIGN USING VIRTUAL INSTRUMENTATION 9

Front Panel and Block Diagram – Tools, Controls and Functions palette. Modular programming – SubVI. Structures – FOR, WHILE Loops, Case, Sequence, event structures, Formula node. DAQ hardware – AI, AO, DIO. DAQ Assistant and configuration Applications - Speed, Vibration, strain & temperature Measurement

UNIT V DESIGN OF MECHATRONICS SYSTEMS 9

Pick and place Robot- Autonomous mobile robot-Wireless surveillance balloon- Engine Management system- Automatic car park barrier.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the fundamentals of mechatronics systems such as the components and control schemes with block diagrams	Understand
CO2: Select sensors for various measurements including pressure, temperature, flow, level and light used in different systems	Apply
CO3: Write logic programs for real time applications such as home automation, machine tool control, process control using PLC	Apply
CO4: Design user interface for arithmetic, logical, sequencing data acquisition operations in analog and digital modes using virtual instrumentation.	Apply
CO5: Explain the different mechatronics systems used in various applications	Understand

Text Book(s):

T1 Bolton,W, “Mechatronics” , Pearson Education, 6th edition, 2019.

T2 Jovitha Jerome, ‘Virtual Instrumentation using Lab VIEW’, PHI Learning Private Limited, New Delhi, Second Printing, 2011.

Reference(s):

R1. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.

R2. Devadas Shetty and Richard A.Kolk, “Mechatronics systems design”, PWS Publishing company 2007.

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R3. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications” Tata McGraw-Hill Publishing company Limited, 2017.

Web References

1. https://en.wikipedia.org/wiki/Mechatronics
2. http://www.cedrat.com/en/publications/categories/devicesystems/systems/mechatronics.html
3. http://nptel.ac.in/courses/112103174/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	1	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	1	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	1	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	1	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	1	-

High-3; Medium-2;Low-1

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Course Code: 19MECC1701		Course Title: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (Common to AU,ME &MC)	
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Prerequisites

The student should have undergone the courses:

- Nil

Course Objective

The course is intended to

1. Explain the basics of Artificial Intelligence and applications.
2. Explain search methods to achieve a goal.
3. Explain first-order logic to represent knowledge.
4. Explain the basics of machine learning and applications.
5. Explain the various machine learning techniques.

UNIT I ARTIFICIAL INTELLIGENCE – INTRODUCTION 9

AI - definition. Foundations of AI - History, trends and future. Intelligent Agents - agents and environments, the concept of rationality, the nature of environments, the structure of agents and types-case studies of Artificial Intelligence.

UNIT II PROBLEM SOLVING BY SEARCH 9

Problem solving agents, searching for solutions- Infrastructure for search algorithms, measuring problem-solving performance. Uninformed search strategies- Breadth-first search, Depth-first search, Iterative deepening search, Uniform-cost search, Bidirectional search, Comparing uninformed search strategies. Heuristic functions, Informed (heuristic) search strategies- Best first search.

UNIT III KNOWLEDGE REPRESENTATION 9

Introduction to Knowledge Representation- Hypothesis, Reasoning, Representing Knowledge, Syntax and semantics of Knowledge Representation language, Propositional-

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Logic. First-order logic: syntax and semantics of first-order logic, knowledge engineering in first-order logic, inference in first-order logic.

UNIT-IV INTRODUCTION TO MACHINE LEARNING 9

Introduction: Basic definitions, types of learning, hypothesis, space and inductive bias, evaluation, cross-validation- Linear regression- R programming, Decision trees, over fitting-Instance based learning, Feature reduction, Collaborative filtering based recommendation- Probability and Bayes learning.

UNIT-V MACHINE LEARNING TECHNIQUES 9

Introduction: Neural network - Perceptron, multilayer network, back propagation. Introduction to deep neural network- Computational learning theory, PCA learning model, Ensemble learning- Clustering: k-means, adaptive hierarchical clustering.-case studies on Machine Learning.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic concept, and application of Artificial Intelligence.	Understand
CO2: Explain uninformed and informed search methods for problem solving.	Understand
CO3: Explain knowledge representation using first order logic.	Understand
CO4: Explain the basic concept, and application of Machine Learning.	Understand
CO5: Explain the classification and clustering techniques for decision making.	Understand

Text books:

T1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence- A Modern Approach", Fourth Edition, Pearson Series, 2021.

T2. Tom M. Mitchell, "Machine Learning", McGraw hill, 2013.

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<u>Reference books</u>:

R1. George Lugar, .AI-Structures and Strategies for and Strategies for Complex Problem solving, Sixth Edition, 2009, Pearson Educations.

R2. E. Rich and K. Knight, “Artificial intelligence”, McGraw Hill, 3rd ed., 2017.

R3. Robin R Murphy, Introduction to AI Robotics PHI Publication, 2nd edition,2019.

R4. Nils.J. Nilsson, “Principles of AI”, Narosa Publ. House, 2000.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	1	-	1	-	1	1	-
CO2	2	1	-	-	1	-	-	1	-	1	-	1	1	-
CO3	2	1	-	-	1	-	-	1	-	1	-	1	1	-
CO4	2	1	-	-	1	-	-	1	-	1	-	1	1	-
CO5	2	1	-	-	1	-	-	1	-	1	-	1	1	-

High-3; Medium-2;Low-1

Course Code: 19MECN2701	Course Title: CNC MACHINES AND ROBOTICS		
Course Category: Professional Core		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours:75	Max Marks:100

Prerequisites

- Manufacturing Technology

Course Objectives

The course is intended to:

1. Distinguish different CNC machines.
2. Explain the different part program of CNC Turning centre.
3. Explain the different part program of CNC Machining centre.
4. Explain different parts of Robot.
5. Explain the Robot programming language

UNIT I INTRODUCTION AND FEATURES OF CNC MACHINES 9

CNC Machine Tools - principles, features, advantages, applications. CNC and DNC concept. Turning centre, machining centre. Types of control systems, CNC controllers, main drive, timing belts and pulleys, spindle bearings, Re-circulating ball screws, linear motion guide ways, tool turrets, tool magazines, ATC, APC, chip conveyors, encoders, hard jaws and soft jaws.

UNIT IIPART PROGRAMMING OF CNC TURNING CENTRE 9

Process planning, Co-ordinate systems, structure of a part program, typical tools for turning centre and machining centre, Machine datum and work piece datum, absolute and incremental programming, G and M Codes, tool offset information, tool nose radius compensation, canned cycle, facing cycle, turning cycle, threading cycle, peck drilling cycle, part programming examples.

UNIT III PART PROGRAMMING OF MACHINING CENTRE 9

Co-ordinate systems, Cutter radius compensation, Tool length compensation, main program and sub program, canned cycle drilling cycle, tapping cycle, boring cycle, programming for circular and rectangular pocketing operations, part programming examples. CAD/CAM based NC programming, features of CAM packages, generation of CNC codes from CAM packages.

UNIT IV INTRODUCTION AND FEATURES OF ROBOT 9

Robotics and automation, laws of robotics, robot definition, types and components of a robot, classification of robots, kinematics systems; definition of mechanisms and manipulators, degrees of freedom various manipulator. power transmission systems and control systems, robot drive mechanisms, mechanical transmission method, end effectors and its types, sensors and actuators.

UNIT V KINEMATICS OF ROBOT MANIPULATOR 9

Co-ordinate and vector transformation using matrices, rotation matrix, inverse transformations, homogenous transformations, Robotic manipulator joint coordinate system, Euler Angle & Euler transformations, Roll Pitch Yaw (RPY) transformation, D-H representation & displacement matrices for standard configurations, Robot programming types, interlocking and robot programing for real time applications.

List of Experiments 30

1. Develop a CNC Program and produce a part using CNC turning centre.
2. Develop a CNC Program and produce a part using CNC milling machine.
3. Develop a CNC Program and produce a hole using CNC drilling machine.
4. Develop a Robot program and perform the process of material handling in robot.
5. Develop a Robot program and perform the welding operation by using robot.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the construction and features of CNC machines.	Understand
CO2: Develop a part program to produce a component by CNC lathe.	Apply
CO3: Develop a part program to produce a component by CNC machining centre.	Apply
CO4: Explain the construction and features of Robot.	Understand
CO5: Develop a Robot program for welding and material handling application.	Apply

Text Book(s):

T1 Radhakrishnan .P, “Computer Numerical Control CNC Machines” New central books, 2013.

T2 Mikell .P. Groover, Mitchell weiss, Roger N Nagel G Odrey, “Industrial Robotics”, Mc-Graw Hill, 2012.

T3 Saha, S.K., “Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

Reference(s):

R1. Yoram Koren, “Computer Control of Manufacturing Systems”, Mc-Graw Hill,1st Edition, 2017.

R2. Richard D Klafter, “Robotic engineering: an integrated approach, Prentice Hall Pvt. Ltd., 2011.

R3. Ghosal Ashitava., “Robotics – Fundamental Concepts and Analysis”, Oxford Higher Education, New Delhi, 2006.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	2	1	-	-	-	-	-	1	1	2	-	2	1	1
CO2	3	2	1	1	1	-	-	1	1	2	-	2	2	1
CO3	3	2	1	1	1	-	-	1	1	2	-	2	2	1
CO4	2	1	-	-	-	-	-	1	1	2	-	2	1	1
CO5	3	2	1	1	1	-	-	1	1	2	-	2	2	1

High-3; Medium-2; Low-1

Assessment pattern

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment – Practical	1,2,3,4,5	75	10
	Final Assessment – Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

Course Code: 19MECC3701	Course Title: SIMULATION AND ANALYSIS LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 3	Credits:1.5	Total Contact Hours: 45	Max Marks:100

Prerequisites

The student should have undergone the course(s):

- Numerical Methods
- Strength of Materials
- Theory of Machines

Course Objective

The course is intended to

1. Apply finite element simulation software
2. Write programs in a mathematical simulation software

Simulation Lab

1. Simulation of Air conditioning system with condenser temperature and evaporator temperatures as input to get COP using Simulation software.
2. Simulation of free vibration characteristics of spring, mass and damper system using Simulation software.
3. Simulation of Hydraulic / Pneumatic cylinder using Simulation software.
4. Simulation of cam and follower mechanism using Simulation software.

Analysis (Simple Treatment Only)

1. Stress analysis of beams (Cantilever, Simply supported)
2. Stress analysis of rectangular L bracket
3. Stress analysis of an Axi-symmetric component
4. Mode frequency analysis of a 2 D component
5. Mode frequency analysis of beams(Simply supported, Fixed ends)
6. Harmonic analysis of a 2D component
7. Thermal stress analysis of a 2D component
8. Conductive and Convective heat transfer analysis of a 2D component
9. Stress analysis of an 3 D component

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply finite element simulation software to solve simple problems such as structural, thermal and vibration problems in Mechanical Engineering.	Apply
CO2: Write programs in a mathematical simulation software to solve mathematical model of mechanical engineering applications	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	2	3	2	-	-	3	-
CO2	3	2	2	2	2	-	-	2	3	2	-	-	3	-

High-3; Medium-2; Low-1

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Course Code: 19MECN3701	Course Title: MECHATRONICS LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Prerequisites

The student should have undergone the courses:

- Electrical and Electronics Engineering

Course Objective

The course is intended to

1. Design a Pneumatic circuit for cylinder actuation.
2. Develop logic Program for real time interfacing
3. Develop a user interface for measurements

List of Experiments

1. Design a Pneumatic circuit for speed regulation of double acting.
2. Design a Pneumatic circuit for actuation of single and double acting cylinder using Mechanical actuation.
3. Design a Pneumatic circuit for actuation of single and double acting cylinder using Electrical actuation.
4. Develop a CASCADE circuit for given sequence operation (two and three cylinders).
5. Basics logic using PLC Programming - AND, OR, Latch, Interlock
6. Control of multiple actuators in Hydraulic and pneumatic System by using PLC TIA portal V14
7. Control of Bottle filling system using PLC
8. Creating simple VIs, Editing and Debugging
9. Creating Sub VI using Lab VIEW
10. Temperature signal interface using Lab VIEW
11. Vibration Measurement using Lab VIEW

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Design a Pneumatic circuit for actuation of single and double acting cylinder using Mechanical and Electrical actuators	Apply
CO2: Develop a logic Programme for real time interfacing using plc for fluid power system, logic function and bottle filling.	Apply
CO3: Develop a user interface for temperature and vibration measurement using	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	2	3	2	-	1	3	-
CO2	3	2	2	2	1	-	-	2	3	2	-	1	3	-
CO3	3	2	2	2	1	-	-	2	3	2	-	1	3	-

High-3; Medium-2; Low-1

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SEMESTER VIII

Course Code: 19MEPN6801	Course Title: PROJECT		
Course Category: Project		Course Level: Practice	
L:T:P (Hours/Week) 0: 0: 16	Credits:8	Total Contact Hours:240	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Work collaboratively on a team to successfully complete a design project
3. Effectively communicate the results of projects in a written and oral format

The objective of Project is to enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental committee.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Take up any challenging practical problems and find solution by formulating proper methodology.	Apply
CO2: Work collaboratively on a team to successfully complete a design project	Create
CO3: Effectively communicate the results of projects in a written and oral format	Apply

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	-	-	-	3	3	-	-
CO2	-	-	3	-	-	-	-	3	3	-	3	3	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	3	-	-

High-3; Medium-2; Low-1

Course Code: 19MEPN6003	Course Title: INTERNSHIP (Common to all B.E/B.Tech Programmes)		
Course Category: Project		Course Level: Practice	
L:T:P (Hours/Week) 8/16 Weeks	Credits: 4	Total Contact Hours: Nil	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Understand industry-specific terminology and practices
2. Solve simple industrial problems
3. Work collaboratively on a team
4. Effectively communicate the activities of internship in a written and oral format

Minimum of 8/16 weeks in an Industry in the area of Mechanical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Understand industry-specific terminology and practices	Understand
CO2: Solve simple industrial problems	Apply
CO3: Work collaboratively on a team	Create
CO4: Effectively communicate the activities of internship in a written and oral format	Apply

End of Semester VIII

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Semester VIII

Course Code: 19SHVG6001		Course Title: Entrepreneurship Development	
Course Category: Humanities		**Course Level: Introductory**	
L:T:P (Hours/Week) 1: 0: 0	**Credits: 1**	**Total Contact Hours: 15**	**Max Marks:100**

Course Objectives:

The course is intended to equip students with the entrepreneurial mindset, understand market, apply the process of problem solving, and Entrepreneurship ecosystem.

Entrepreneurship **15 Hours**

Entrepreneur- Types of Entrepreneurship-Problem identification-Opportunity Discovery-Explore Market, customer persona-customer segmentation, TAM,SOM,SAM- creating compelling value proposition- competitor analysis. Prototying- Types -Business model canvass-Idea pitching. Entrepreneurial eco system- Startups-Angel Investors, Venture Capitalist, Makers Space, Incubators, Accelerators-Financial models- Equity, Debt, Crowd funding.

Course Outcomes	Cognitive Level
At the end of the course, students will able to	
CO1: Pitch an Idea for a problem with understanding entrepreneurial ecosystem.	Apply

Text Book(s):

1. Robert D.Hisrich, Micheal P. Peters, Dean A. Shepherd, Sabayasachi (2020), Entrepreneurship,McGrawHill, 11th Edition.
2. Donald F Kuratko,Entrepreneurship: Theory, Process, Practice with MindTap, 11th Edition.

Web References:

1. https://wadhwanifoundation.org/our-programs/ignite/
2. https://academy.forge-iv.co/#academia

Assessment Plan:

Internal Component:

Idea Pitching Presentation- 75 Marks

End Semester Assessment: 1. 25 Multiple Choice Questions- 25 Marks

<table>
<tr><td colspan="2">Course Code: 19SHVG6002</td><td colspan="2">Course Title: தமிழர் மரபும் பண்பாடும்</td></tr>
<tr><td colspan="2">Course Category: Humanities</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
1: 0: 0</td><td>Credits:1</td><td>Total Contact Hours:15</td><td>Max Marks:100</td></tr>
</table>

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்பதன் மூலம்:

இந்திய தேசிய இயக்கத்திற்கும் இந்திய கலாச்சாரத்திற்கும் தமிழர்களின் பங்களிப்பை அறிந்து கொள்ள இயலும்.

அலகு 1 - **தமிழ் மொழி மற்றும் இலக்கியம்** **5 Hours**

தமிழ் ஒரு செம்மொழி - சங்க இலக்கியங்கள் - திருக்குறள் - தமிழ்க் காப்பியங்கள் - தமிழகத்தில் சமண, பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம் - ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு

அலகு **2 -** தமிழர் கலைகள் மற்றும் விளையாட்டுகள் **5 Hours**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - நாட்டுப்புறத் தெய்வங்கள் - குமரி முனையில் திருவள்ளுவர் சிலை - இசைக்கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்

அலகு **3 -** இந்தியாவின் பண்பாடு மற்றும் வளர்ச்சியில் தமிழர்களின் பங்கு **5 Hours**

சங்ககால நகரங்களும், துறைமுகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி. இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO.1 இந்திய தேசிய இயக்கத்திற்கும் இந்திய கலாச்சாரத்திற்கும் தமிழர்களின் பங்களிப்பை அறிந்து கொள் வார்கள்.	அறிதல் (Understand)

Text Book(s):

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
3. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
5. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

Course Code: 19SHVG6002		Course Title: CULTURE AND HERITAGE OF TAMILS	
Course Category: Humanities		**Course Level: Introductory**	
L:T:P (Hours/Week) 1: 0: 0	**Credits:1**	**Total Contact Hours:15**	**Max Marks:100**

Course Objectives

The course is intended to:

- Understand the Contribution of Tamils to Indian National Movement and IndianCulture.

UNIT I – TAMIL LANGUAGE AND LITERATURE **5 Hours**

Tamil as a Classical Language - Sangam Literature – Thirukural - Tamil Epics - Impact of Buddhism and Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II – FINE ARTS AND MARTIAL ARTS OF TAMILS **5 Hours**

Hero stone to modern sculpture - Bronze icons - Village deities, Thiruvalluvar Statue at Kanyakumari, Musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils - Folk and martial arts.

UNIT III – CONTRIBUTION OF TAMILS TO INDIAN CULTURE AND GROWTH **5 Hours**

Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas. Contribution of Tamils to Indian Freedom Struggle - Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions and Manuscripts – Print History of Tamil Books.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO.1 Understand the Contribution of Tamils to Indian National Movement and Indian Culture.	Understand

Text Book(s):

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
3. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
5. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

ELECTIVES

<table>
<tr><td colspan="2">Course Code: 19MEEN1023</td><td colspan="3">Course Title: RAPID PROTOTYPING AND TOOLING</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

- Nil

Course Objectives

The course is intended to:

1. Explain the process chain of rapid prototyping.
2. Explain the liquid based and solid based rapid prototyping systems.
3. Explain the powder based rapid prototyping systems.
4. Explain the model creation techniques in reverese engineering.
5. Explain the rapid tooling system process.

UNIT I INTRODUCTION 7

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital prototyping - Virtual prototyping.

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS 10

Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, Three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 10

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

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UNIT IV REVERSE ENGINEERING AND CAD MODELING 10

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

UNIT V RAPID TOOLING 8

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1:Explain the process chain of rapid prototyping.	Understand
CO2:Explain the liquid based and solid based rapid prototyping systems.	Understand
CO3:Explain the powder based rapid prototyping systems.	Understand
CO4:Explain the model creation techniques in reverese engineering.	Understand
CO5:Explain the rapid tooling system process	Understand

Text Book(s):

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

Reference(s):

1. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2. Rapid Prototyping and Engineering applications : A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
3. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

4. High-3; Medium-2; Low-1

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Course Code: 19MEEN1001	Course Title: MECHANICAL SYSTEM DESIGN		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Numerical Methods

Course Objectives

The course is intended to:

1. Explain the engineering process and system approach.
2. Explain the system theories and system modeling concepts.
3. Apply the mathematical formulation in system design and optimization concepts.
4. Apply the decision analysis principles and system simulation concepts.
5. Apply the financial analysis to evaluate the system performance.

UNIT I SYSTEM APPROACH AND PROBLEM FORMULATION 9

Engineering processes- Role of an Engineer in Mechanical system Design, Engineering Problem solving. System approach-Application of system concepts, Characteristics of systems, elements of systems, Types of systems. Problem formulation-Problems and forming models, nature of engineering problems, problem characteristics, problem environment, problem statement and techniques involved in defining a problem, a case study.

UNIT II SYSTEM THEORIES AND SYSTEM MODELING 9

System Theories-Black box approach, state theory approach, component integrated approach, decision theory approach. System Modeling-Need of modeling, modeling process, principles, modeling types-static physical model, dynamic physical model, static mathematical model, dynamic mathematical model, a case study on system modeling.

UNIT III MATHEMATICAL FORMULATION IN MECHANICAL DESIGN 9

Mathematical Formulation in System Design-Linear Programming Problem- Graphical method, Simplex method, Network Flow analysis- critical path method, and probability of

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completion time. Optimization Concepts-optimization in engineering applications, ingredients and classifications, statement of optimization, design vector, constraints, objective function, Optimization concept in single variable optimization and multi variable optimization problem.

UNIT IV DECISION ANALYSIS AND SYSTEM SIMULATION 9

Decision analysis-Elements of decision problem, decision making under certainty, decision making under uncertainty, decision models- quantitative methods, decision tree. System Simulation concepts- types of simulation models, simulation programs and languages, Monte Carlo simulation , waiting line simulation.

UNIT V SYSTEM EVALUATION 9

System evaluation-Request for proposals, Evaluation factors, stage of evaluation, Needs and benefits, Feasibility assessment, planning horizon. Financial analysis of system performance-Average rate of return method, Payback period, Balance sheet- profit and loss statement, a case study.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1:	Explain the engineering process and system approach to formulate a problem.	Understand
CO2:	Explain the system theories and system modeling concepts to study the system behavior.	Understand
CO3:	Apply the mathematical formulation in system design and optimization concepts to optimize the system.	Apply
CO4:	Apply the decision analysis principles and system simulation concepts optimize the system.	Apply
CO5:	Apply the financial analysis to evaluate the system performance.	Apply

Text Book(s):

T1. R.C Mishra and Simant, “Mechanical System Design: PHI learning, New Delhi, 2017.

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T2. K.U. Siddiqui and Manojkumarsingh, "Mechanical system Design"-New Age international Publishers, 2nd edition 2010.

Reference(s):

R1. S.S.Rao "Engineering Optimization-Theory and Practice" New Age international Publishers, 2009.

R2. S.Kalavathy "Operations Research" 4th Edition Vikas Publishing House, 2013.

R3. Ramachandran Aryasry & VV.Ramana Murthy, "Engg Economics & Financial Accounting", Tata McGraw-Hill Company, 3rd Edition, NewDelhi, 2009.

Web References:

1. http://content.asce.org/files/pdf/team20102Mechanical_systems_designpresentation.pdf
2. http://www.engr.mun.ca/~yuri/Courses/MechanicalSystems/Design.pdf
3. http://www.coursera.org

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code:19MEEN1024	Course Title: Design for X		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the courses:

- Manufacturing Technology
- Mechanical Design

Course Objectives

The course is intended to:

1. Elaborate the design principles for manufacturability.
2. Discuss the factors influencing in form design.
3. Apply the component design features of various machining.
4. Apply the component design features of casting consideration.
5. Apply design consideration principles for additive manufacturing.

UNIT I INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances, Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

UNIT II FACTORS INFLUENCING FORM DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by

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separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT IV COMPONENT DESIGN - CASTING CONSIDERATION 9

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.

UNIT V DESIGN FOR ADDITIVE MANUFACTURING 9

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Elaborate the design principles for manufacturability.	Understand
CO2: Discuss the factors influencing in form design.	Understand
CO3: Apply the component design features of various machining consideration.	Apply
CO4: Apply the component design features of casting consideration.	Apply
CO5: Apply design consideration principles for additive manufacturing.	Apply

Text Book(s):

T1. James G. Bralla, “Design for Manufacturability Handbook”, McGraw Hill Professional, 2nd edition, 2020.

T2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer,1998.

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Reference(s):

R1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.

R2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.

R3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.

Web References:

1. https://nptel.ac.in/courses/112107217
2. http://www.coursera.org

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code: 19MEEC1007</td><td colspan="3">Course Title: DESIGN FOR SHEET METAL
(Common to AU & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the courses:

- Manufacturing Technology
- Strength of materials

Course Objectives

The course is intended to:

1. Calculate the forces involved in bending and drawing operations.
2. Select appropriate press tools.
3. Select appropriate press machines.
4. Suggest a suitable bending process.
5. Estimate the cost required for forming and tube bending.
6. Choose a suitable sequence and tool for forming and tube bending processes.

UNIT I SHEET METAL & FORMING PROCESS 9

Basics of forming, bending & drawing process, Advantages and its Applications in Automotive Parts. Terminology of forming & bending- Bending force & Blank holding force Calculations, Spring Back, Bending defects and remedies. terminology of drawing - Working principle of drawing operations and reverse drawing, Calculation of Draw force, Calculation of cutting force, Blanking & Piercing, Blank holding force (Die cushion), Blank development - No of Draws - Selection of Press tonnage, defects, causes and remedies in drawing operation.

UNIT II PRESS TOOLS 8

Types of forming and press tools, Basis of selection of forming and press tool, Tool steel and merits, demerits and its applications, Tool Design, Tool Maintenance, Punches Types of Punches and Punch tool requirements.

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UNIT III PRESS MACHINES 8

Presses - Types of Press machines based on Source of Power, Press tonnage, Slide Actuation & Capacity and its merits & demerits and application of presses and Material handling devices or equipment's and its types- Economic factor & selection of press.

UNIT IV TUBE BENDING PROCESS AND EQUIPMENTS 9

Tube bending process -Types of tube bending operation - Equipment's of Tube bending – Conventional type pipe bending machine - clamp - wiper shoe - Bend form – Mandrel, pipe bending machine. Compression Bending, Rotary Draw Bending, Press Bending, Roll Bending, Single or double bend ,3D Bend, Tube on Tube bend, Tube bending related to shapes & size-Round, Rectangular & Square, Materials used Tube bending parts.

UNIT V TOOL COSTING AND SELECTIONS 11

Cost drivers for formed part – Tool cost estimation - Trial & Inspection cost overhead cost & profit. Calculation of cost drivers of formed parts. Determination of Sequence and Tool selection - Sequence of operation available in the given part - Blanking tool & Piercing tool design - Draw the component drawing & Strip layout - Draw the assembly of tool drawing & BOM - Draw the individual tool elements part drawing for Manufacturing. Prepare the process planning chart. Inspection, trials and Troubleshooting - checklist for tool in static condition - checklist for tool in Dynamic condition - general inspection methods. Specific inspection methods (Panel checker/acceptance gauge). Design of form blocks and rubber press forming for aerospace application and stretch forming.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1:	Calculate the forces involved in bending and drawing operations such as bending force, drawing force and blank holding forces.	Apply
CO2:	Select appropriate press tools for forming processes based on the geometry and material of the given part.	Apply
CO3:	Select appropriate press machines for forming processes based on the geometry and material of the given part.	Apply
CO4:	Suggest a suitable bending process based given part geometry and material.	Apply
CO5:	Estimate the cost required for forming and bending for the given part.	Apply

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Text Book(s):

T1. Serope Kalpakjian and Steven R. Schmid, “Manufacturing Engineering and Technology”, 7th edition, Pearson Education, 2018.

T2. S.K. HajraChoudhury and A.K. HajraChoudhury, “Elements of Work shop Technology”, Vol – I Manufacturing Processes, Media Promoters and Publishers Pvt. Ltd, 2018.

Reference Book(s):

R1. S.L. Semiatin “ASM Handbook Volume 14B: Metalworking: Sheet Forming”, 2006.

R2. Schuler “Metal Forming Handbook”, Springer-Verlag Berlin Heidelberg 1998

R3. Kurt Lange, "Handbook of Metal Forming", Society of Manufacturing Engineers,1985

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1004	Course Title: DESIGN FOR WELDING		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the courses:

- Engineering Metrology and Measurements
- Engineering Materials

Course Objectives

The course is intended to:

1. Choose a suitable welding process.
2. Identify the potential failure modes of a weld joint.
3. Explain the types of fixtures used in welding processes.
4. Design a suitable welding fixture.
5. Explain inspection, maintenance and calibration procedure.

UNIT I INTRODUCTION 9

Fundamentals of welding Process - Arc welding processes - Principle and operation - Advantages and limitations of welding processes - Power sources of arc welding process and their influence on the process behavior - MIG / MAG Welding - Metal transfer in MIG welding processes-Process requirements of GMAW process - Impact of Process parameters - Defects of GMAW, Causes and their remedies - Resistance Welding Processes - Various types of Resistance welding process and its applications - Process requirements of Resistance Welding process - Impact of Process parameters – Resistance welding defects, causes and their remedies.

UNIT II DESIGN OF WELD JOINTS 9

Types of Weld Joints and their applications - Styles and practices of Edge preparation - Representation of Weld symbols - Loads acting on the Weld Joints - Calculation of Stresses in Weld Joints - Determination of Weld size for Fatigue Applications -Effect of Temperature on Metallurgical properties - Causes of Distortion - Causes for Residual

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Stresses - Quality requirement for Welders - Qualification Tests for welder - Optimization of Weld Process - Estimation of Welding Costs for a given application.

UNIT III INTRODUCTION TO WELDING FIXTURES 9

Fixtures and its types - Datum and its importance of the Part - Location and its importance of the Part - Orientation and its importance of the Part - Resting & Clamping and its importance of the Part - Elements of the welding fixture - Different fixture accessories used for welding fixture assembly - Different types of welding fixtures for Resistance welding Process- Different types of welding fixtures for Arc welding Process. [SMAW&MIG].

UNIT IV DESIGN OF FIXTURES FOR WELD PARTS 9

Critical & Major dimension of the fixture part - Datum and its classifications - Location, orientation & clamping for the weld part - Design of fixture elements for the given weld joint - Design of FMEA for the pre designed concept fixture -Welding distortion control by using fixture clamping - Design of welding fixture drawing for a given part.

UNIT V INSPECTION AND VALIDATION OF WELDING FIXTURES 9

Inspection procedure for welding fixtures - Critical fit function of fixture hold part – Need of tolerance in fixture assembly-Possible failure modes while inspection of fixtures –Need of Fixture Maintenance and Calibration-Fixture maintenance procedure - Different fixture maintenance tools - Fixture calibration procedure.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Choose suitable welding processes.	Apply
CO2: Identify the potential failure modes of a weld joint.	Apply
CO3: Explain the types of Fixtures used in welding process.	Understand
CO4: Design the welding fixtures for the given weld parts.	Apply
CO5: Explain the inspection, maintenance and calibration procedure of welding fixtures.	Understand

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Text Book(s):

T1. O.P Khanna "A Textbook of Welding Technology", Dhanpat Rai & Sons, Twentieth Reprint, 2011.

T2. Omer. W.Blodgett, James F. Lincoln, "Design of Welded Structures,rc Welding Foundation", 1st Edition 1996.

T3. Prakash Hiralal Joshi, "Welding and Assembly Fixtures", McGraw-Hill Professional, 2010.

Reference Book(s):

R1. S.J Maddox, "Fatigue Strength of Welded Structures", Woodhead Publishing, 1991.

R2. T.R Gurney, Tim Gurney, "Fatigue Strength of Transverse Fillet Welded Joints: A Study of the Influence of Joint Geometry", Woodhead Publishing, 1991.

Web References:

1. https://ocw.mit.edu/courses/materials-science-and-engineering/3-37-welding-and-joining-processes-fall-2002/lecture-notes/
2. http://www.esabna.com/euweb/awtc/lesson1_1.htm

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td colspan="2">Course Code: 19MEEN1025</td><td colspan="3">Course Title: Design Thinking</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

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Course Objectives

The course is intended to:

1. Introduce tools & techniques of design thinking for innovative product development
2. Illustrate customer-centric product innovation using on simple use cases
3. Demonstrate development of Minimum usable Prototypes
4. Outline principles of solution concepts & their evaluation
5. Describe system thinking principles as applied to complex systems

UNIT I DESIGN THINKING PRINCIPLES 9

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR - Case studies

UNIT II ENDUSER-CENTRIC INNOVATION 9

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

UNIT III APPLIED DESIGN THINKING TOOLS 9

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

UNIT IV CONCEPT GENERATION 9

Conceptualization: Visual thinking, Drawing/sketching, New concept thinking, Patents and Intellectual Property, Concept Generation Methodologies, Concept Selection, Concept Testing - build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts.

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UNIT V PRODUCT DESIGN AND SYSTEM THINKING 9

Sustainable product design, Ergonomics, Semantics, Entrepreneurship/business ideas, Product Data Specification, Establishing target specifications, Setting the final specifications. System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain Introduce tools & techniques of design thinking for innovative product development	Understand
CO2: Develop customer-centric product innovation for simple cases	Apply
CO3: Develop Minimum usable Prototypes	Apply
CO4: Explain the concept generation and validation processes	Understand
CO5: Describe system thinking principles as applied to complex systems	Understand

Text Book(s):

T1. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, McGraw-Hill, Penguin Random House India, 2020.

T2. IdrisMootee, Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School , Wiley,2014.

T3. Ulrich, Karl T., Eppinger,Steve D.,and Yang, Maria C, Product Design and Development, 7th ed., McGraw-Hill Education,2020.

Reference(s):

R1 Tim Brown, Change by Design, Revised and Updated: How Design Thinking Transforms Organizations and Inspires Innovation.

R2 Donella H. Meadows, "Thinking in Systems -A Primer", Sustainability Institute,2015

R3 Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, Value Proposition Design: How to Create Products and Services Customers Want, Wiley,2014.

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Web References:

1. https://nptel.ac.in/courses/110106124
2. https://onlinecourses.nptel.ac.in/noc23_me52/preview

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1026	**Course Title: REVERSE ENGINEERING**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. To explain the fundamentals of reverse engineering in product design
2. To explain the tools and techniques for reverse engineering
3. To explain concept and principles of data processing, part Performance and system compatibility in reverse engineering.
4. To the additive manufacturing process for industrial applications.
5. To explain applications of reverse engineering in product design and development.

UNIT I INTRODUCTION TO REVERSE ENGINEERING 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering, Need of reverse engineering, Methodologies for Reverse Engineering, understanding of Reverse Engineering through example, Phases of Reverse, Engineering, conceptual System Reasons for Reverse Engineering, Difficulties in Reverse Engineering, Levels of abstraction: Application level, Functional level, Structural level, Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II TOOLS AND TECHNIC FOR REVERSE ENGINEERING 9

Object scanning: Contact scanners, noncontact scanners and destructive method, coordinate measuring machine, point data processing, pre-processing and post processing of captured data, geometric model development, construction of surface model, solid model, noise reduction, feature identification, model verification.

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UNIT III DATA PROCESSING **9**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis –Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT IV ADDITIVE MANUFACTURING **9**

Additive Manufacturing Technology in product development-Materials for Additive Manufacturing Technology, Classification – Stereo lithography(SLA)- Principle, process, advantages –Fused Deposition Modeling – Principle, process, advantages. Selective Laser Sintering – Principle, Process Three Dimensional Printing – Principle, process, advantages - Laser Engineered Net Shaping (LENS)

UNIT V INDUSTRIAL APPLICATIONS **9**

Reverse Engineering in the Automotive Industry, Aerospace Industry and Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Explain the fundamental concepts and principles of reverse engineering in product design and development.	Understand
CO2: Explain the tools and techniques for reverse engineering	Understand
CO3: Explain the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.	Understand
CO4: Explain the additive manufacturing process for industrial applications	Understand
CO5: Explain the applications of reverse engineering in product design and development.	Understand

Text Book(s):

T1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014

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T2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

Reference(s):

R1. Scott J. Lawrence, Principles of Reverse Engineering, Kindle Edition, 2022

R2. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, Springer Verlag London Limited 2008.

R3. Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEC1005	Course Title: DESIGN OF TRANSMISSION SYSTEM (Common to MC & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Theory of Machines

Course Objective

The course is intended to

1. Design a suitable flexible element.
2. Design a spur gear and helical gear drives.
3. Design bevel and worm gear drives.
4. Design a multi stage sliding mesh gear box.
5. Design single, multi plate clutch and brakes.

UNIT I SELECTION OF FLEXIBLE ELEMENT DRIVES 9

Mechanical drives-types of drives -power and motion transmission drives-stepped and steeples transmission-speed ratio-under direct and over drives and its applications-reversible and irreversible drives and its applications-belt drives and its applications-Select suitable flat belt and V-belt drives and pulleys for industrial applications-chain drives-hoisting and hauling chains -Conveyor Chains -Power transmitting chains-block chain-roller chain-silent chain-select suitable roller chains and sprockets for industrial applications.

UNIT II DESIGN OF SPUR GEAR AND HELICAL GEAR DRIVES 9

Toothed gearing and its applications- gear tooth terminology- failures in gears- gear materials- law of gearing- tooth forces and stresses- Design of spur gear for given situations, helical gear - Tooth terminology - equivalent number of teeth – Design of Helical Gear drives for given situations, Cross helical: Terminology (Qualitative Treatment only).

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UNIT III DESIGN OF BEVEL AND WORM GEAR DRIVES 9

Types of bevel gear - Tooth terminology - equivalent number of teeth gear, Design the bevel gear, Materials- Worm Gear terminology , Types of worm gears - equivalent number of teeth, gear Materials, Thermal capacity, Efficiency - Tooth forces and stresses of worm gears, Design of worm gear drives.

UNIT IV DESIGN OF SLIDING MESH GEAR BOX 9

Preferred numbers- Geometric progression- standard step ratio- kinematic layout- ray diagram- Design 3, 6, 9 and 12 sliding mesh speed gear box.

UNIT V DESIGN OF CLUTCHES AND BRAKES 9

Needs and role of clutch- types of clutch-positive clutch- square jaw clutch- spiral jaw clutch- friction clutch- types of friction clutch-plate clutches- cone clutch- centrifugal clutch- Design of plate clutches- needs and role of brakes- types of brakes -single block or shoe brake- pivoted block or shoe brake- double block or shoe brake- simple band brake- differential band brake- band and block brake- internal expanding brake- Design of shoe brake, band and block brake, internal expanding brake, Disc Brake.

NOTE: (Use of approved Data Book is permitted in the End semester examination)

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design a suitable flexible element drives such as flat belt, V-belt and chain drives for power transmitting applications.	Apply
CO2: Design a spur gear and helical gear drives considering the tooth bending and surface strength for given application.	Apply
CO3: Design and analyze a bevel and worm gear drives for strength and surface durability.	Apply
CO4: Design a single/multi stage sliding mesh gear box having maximum of 12 speeds and calculate the output speeds for machine tool applications.	Apply
CO5: Design single, multi plate clutch and brakes such as shoe brake, band brake, block brake, disc brake and internal expanding type brakes for given applications.	Apply

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Text Book(s):

T1. Shigley J.E and Mischke C.R, **"**Mechanical Engineering Design" 9th Edition, Tata McGraw-Hill,2011.

T2. Bhandari V.B, **"**Design of Machine Elements" 5th edition,Tata McGraw-Hill, 2020.

Reference(s):

R1. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.

R2. GitinMaitra, L. Prasad "Hand book of Mechanical Design", 2nd Edition, Tata McGraw-Hill, 2001.

R3. Sundararajamoorthy T.V, Shanmugam N, "Machine Design", Anuradha Publications, Chennai, 2003.

Web References:

1. http://nptel.ac.in/courses/112106137/
2. http://nptel.ac.in/courses/112102014/38
3. http://dunloptransmissions.com/
4. http://www.renold.in/Products/TransmissionChainSprockets/TransmissionChainIndexPage.asp
5. http://khkgears.net/gear-knowledge/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	1	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1008	Course Title: NANOMATERIALS SYNTHESIS AND CHARACTERIZATION		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Material Science

Course Objectives

The course is intended to:

1. Explain the basic of nano technology and describe various dimensional structures of nano materials.
2. Explain the chemical synthesis of nanostructures.
3. Explain physical synthesis of nanostructures.
4. Describe the SEM and TEM process and its inferences.
5. Analyze the crystal parameters using X-Ray diffraction and describe the AFM process and its inferences.

UNIT I INTRODUCTION TO NANO TECHNOLOGY AND NANOSTRUCTURES CLASSIFICATION 9

History of nano science- Terminologies used in nano science- Influence of size reduction on thermal, electrical, mechanical, optical and magnetic properties of nanomaterials- surface area and aspect ratio of nanomaterials. Classifications of nanomaterials- Zero dimensional, one-dimensional, two dimensional and three dimensional nanostructures – Core shell nanoparticles – Kinetics in nanostructured materials- multilayer thin films and nanocomposites.

UNIT II CHEMICAL SYNTHESIS OF NANOSTRUCTURES 9

Sol gel processing- Precipitation, Solvothermal, hydrothermal, spray pyrolysis, Electro spraying and spin coating methods of synthesis of different nanostructures- surfactant assisted synthesis of nanostructures.

UNIT III PHYSICAL SYNTHESIS OF NANOSTRUCTURES 9

Ball milling- Vapour deposition and different types of epitaxial growth techniques (CVD, MOCVD, MBE, ALD)- pulsed laser deposition, Magnetron sputtering- Lithography:

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Photo/UV/EB/ FIB techniques, Dip pen nanolithography.

UNIT IV ELECTRON MICROSCOPY 9

Scanning Electron Microscopy (SEM): Basic Design of the scanning electron microscopy- Modes of operation- Backscattered electrons- Secondary electrons- X-rays- specimen preparation- Application of SEM. Transmission Electron Microscopy (TEM): Basic principles- Modes of operation- specimen preparation- Diffraction in imperfect crystals- Dislocations- Structure of grain boundaries and interfaces- HRTEM use in nanostructures

UNIT V X- RAY DIFFRACTION AND ATOMIC FORCE MICROSCOPY 9

Bragg's law- D Spacing- X- Ray Powder Diffraction- Single Crystal Diffraction Techniques- Determination of Accurate Lattice Parameters- Structure Analysis- Particle Size Analysis using Scherer Formula. Basic concepts- Interaction force- AFM and the optica lever- Scale drawing- AFM tip on nanometer scale structures- Force curves, measurements and manipulations- Feedback control- Different modes of operation- Contact, non-contact and tapping mode.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the properties of nanomaterials based on size reduction and identify the structure of nanomaterials and examine its kinetics.	Understand
CO2: Compare the different chemical synthesis techniques of nanostructure formation in materials	Understand
CO3: Describe the various physical methods of nanostructure formation.	Understand
CO4: Analyze the morphological behaviour of nanomaterials based on SEM and TEM.	Apply
CO5: Analyze the crystal parameters and determine the particle size of nanomaterials by X-ray diffraction techniques and also calculate the roughness of the materials based on atomic force microscopy results	Apply

Text Book(s):

T1. T.Pradeep, Nano "The essentials understanding nanoscience and nanotechnology", McGraw Hill, 2009.

T2. Javier Garcia- Martinez, “Nanotechnology for the energy challenge”, Wiley- VCH verlag GmbH & Co, 2010.

Reference(s):

R1. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties & Applications”, Imperial College Press, 2004.

R2. A.S. Edelstein and R C. Cammarata, Nanomaterials: “Synthesis, Properties & Applications” , Institute of Physics Pub., 1998.

R3. B.D Cullity “ Elements of X-ray Diffraction” , 4 th Edition, Addison Wiley, 2001.

R4. J. Goldstein, D.E. Newbury, D.C. Joy “Scanning Electron Microscopy and X-ray Microanalysis”, 2003.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code:19MEEC1009	**Course Title: ADDITIVE MANUFACTURING** (Common to AU, MC & ME)		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Pre-requisites:

- Manufacturing Processes

Course Objectives:

The course is intended to:

1. Apply the concept of design and process optimization.
2. Select suitable materials for additive manufacturing.
3. Explain the concept of photo polymerization and extrusion process system.
4. Explain the concept of Powder bed fusion and direct energy system.
5. Apply the architecture of IoT in additive manufacturing.

UNIT I DESIGN FOR ADDITIVE MANUFACTURING 9

Introduction of AM – Basic principle-Generic AM process – DFAM concepts and objectives-AM unique capabilities –Exploring design freedoms – Design tools for AM-Guidelines for process selection.

UNIT II MATERIALS FOR ADDITIVE MANUFACTURING 9

Classification of polymer and metallic materials –Properties of AM materials – Application of AM material – Atomic structure and bonding-ceramics – polymer- powdered materials-composites- Multiple materials in AM – Multiple – discrete – porous – blended.

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UNIT III PHOTOPOLYMERIZATION PROCESSES AND EXTRUSION BASED SYSTEM 9

Photopolymerization materials – Reaction Rates – Vector scan SL - SL Resin Curing Process - SL Scan Patterns - Vector Scan Microstereolithography - Mask Projection Photopolymerization Technologies and Processes - Two-Photon SL - Extrusion-Based Systems – Basic Principles - Plotting and Path Control - Fused Deposition Modeling – Materials – Limitation – Bio extrusion - FDM of Ceramics.

UNIT IV POWDER BED FUSION AND DIRECT ENERGY SYSTEM 9

SLS process - Powder Fusion Mechanisms - Powder Handling – Process parameters – Materials – Application – SLM Process – Process parameters – Materials – Application – DMLS process – Process parameters – materials – application – EBM process – process parameters – materials – application – LENS process – process parameters – materials – application.

UNIT V ARTIFICIAL INTELLIGENT IN ADDITIVE MANUFACTURING 9

Overview of AI – Types of intelligent agents – AI model – AI enabled AM - AM-based product development - Intelligent agents for product design - Intelligent agents for process design - Intelligent agents for production - Global methods - Framework of smart AM - Artificial Intelligence Applications in 3D Printing.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply the concept of design and process optimization for Additive manufacturing	Apply
CO2: Select suitable materials in additive manufacturing for various applications.	Apply
CO3: Explain the concept of photo polymerization and extrusion process system	Understand
CO4: Explain the concept of Powder bed fusion and direct energy system.	Understand
CO5: Apply the architecture of IoT in various additive manufacturing process and application	Apply

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Text Book(s):

T1. Ian Gibson, David W.Rosen, Brent Stucker, “Additive Manufacturing Technologies“, Springer, 3rd edition, 2020.

T2. Patri.K.Venuvinod and Weiyin Ma. “Rapid Prototyping” Springer science+ business Media, LLC, 2004.

Reference(s):

R1. Andreas Gebhardt, Hanser “Rapid Prototyping”, Gardener Publications, 2003

R2. LiouW.Liou, Frank W.Liou, “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2007.

R3. Chua C.K. Leong K.F., and Lim C.S., “Rapid prototyping: Principles and application”, Second edition, World Scientific Publishers, 2010.

Web references:

1. https://nptel.ac.in/courses/112/104/112104265/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	2	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	2	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	2	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	2	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	2	-	-

High-3; Medium-2; Low-1

Course Code:19MEEN1005	Course Title: PROCESS PLANNING AND COST ESTIMATION		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Pre-requisites:

- Manufacturing Processes
- Manufacturing Technology

Course Objectives:

The course is intended to:

1. Explain the basic concepts of process planning.
2. Apply manual and computer aided process planning.
3. Explain both direct and indirect costs.
4. Analyze various cost calculation methods.
5. Explain the Break Even Analysis & Cost Management.

UNIT I PROCESS PLANNING, DESIGN AND CONCEPTS OF PROCESS PLAN 9

Introduction- Place of process planning-economics- Process & Production Planning, Process Planning & Concurrent Engineering-Types of production- standardization-Production design & selection. Selection of processes, tools, cutting parameters & machine tools- Jigs and Fixtures - Grouping of processes- Sequencing of operations- Selecting primary manufacturing processes for rough & refined needs-Process capability, Process Charts.

UNIT II MANUAL AND COMPUTER AIDED PROCESS PLANNING & ESTIMATION 9

Retrieval type/variant approach, group technology – generative approach, logics decision tress and tables, axiomatic approach – AI expert systems – feature recognition – applications Concepts, differences. Concepts, differences, different costing methods – classification of costs – cost grid-problems.

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UNIT III DIRECT AND INDIRECT COST COMPONENTS 8

Labour cost–direct, indirect–estimation–labour norms–time study rating – labour cost variances; material cost–direct, indirect–estimation–material issue valuation – material cost variances–problems. Overhead cost - Elements – factory, administrative, sales and distribution expenses–methods of absorbing overheads – Direct Labour, Direct Material Machine Hour Rate methods – depreciation – methods – accounting for service department expenses – problems.

UNIT IV COST CALCULATIONS 10

Machined components–welded components, forged components, powder metallurgy parts, calculation of sales cost, case studies, use of computers in cost estimation, cost of rejection.

OPTIMUM MACHINING CONDITIONS: Taylor's equation, deriving the equation for optimum economic cutting velocity– selection of cutting speed for optimum cost, problems process capability analysis.

UNIT V BREAK EVEN ANALYSIS & COST MANAGEMENT 9

Concept, make or buy decision, assumptions, merits and demerits of break even analysis, applications. Linear, multi product break-even analysis Learning curves, product life cycle cost analysis -Tools and techniques–activity based costing - concepts, cost drivers; introduction to target costing - need and applications.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic concepts of process planning.	Understand
CO2: Select the various approaches of manual and computer aided process planning and costing.	Apply
CO3: Understand the different components involved in direct and indirect costs.	Understand
CO4: Analyze the cost calculation methods of different manufacturing process.	Apply
CO5: Explain the concept of Break Even Analysis & Cost Management.	Understand

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Text Book(s):

T1. Kannappan D, “Mechanical Estimating and Costing”, Tata McGraw Hill, New Delhi, 2003.

T2. Banga T R and Sharma S C, “Mechanical Estimating and Costing”, Khanna Publishers, 16th Edition, 2011.

Reference(s):

R1. Russell R.S and Tailor B.W, "Operations Management", PHI, 4th Edition, 2003.

R2. Chitale A.V and Gupta R.C, "Product Design and Manufacturing", PHI, 2nd Edition, 2002.

R3. Kesavan R “Process Planning and Cost Estimation”, New Age International Pvt. Ltd., Chennai, 2005.

Web References:

1. https://en.wikipedia.org/wiki/Planning
2. http://nptel.ac.in/courses/Webcourse-contents/IIT Delhi/Computer%20Aided%20Design%20&%20ManufacturingII/Module%20G/Module%20G(5)/p3.htm
3. https://en.wikipedia.org/wiki/Cost_estimate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1006	**Course Title: ADVANCED MANUFACTURING PROCESSES**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the course(s):

- Manufacturing Processes.

Course Objective

The course is intended to:

1. Describe the applications of advanced unconventional machining processes.
2. Explain the basic concepts of advanced casting processes.
3. Select suitable welding process and technique to join a given material.
4. Explain well-founded and realistic process models within metal forming process.
5. Understand E manufacturing, micro and nano materials manufacturing process.

UNIT I ADVANCED UNCONVENTIONAL MACHINING PROCESS 9

Introduction- Shaped tube electro-chemical machining and electro-chemical spark machining, Plasma Arc Cutting, Magnetic abrasive finishing, Magnetorheological abrasive flow finishing, Electric Discharge Grinding, Electric Discharge Diamond Grinding Electrochemical Grinding, Electrostream Drilling, Chemical machining, Photo Chemical Machining, and Bio-Chemical Machining processes.

UNIT II ADVANCED CASTING PROCESSES 9

Special casting process-Shell Moulding, Investment casting, centrifugal casting, Die casting and continuous casting. Low pressure die casting, Squeeze casting, Full mould casting process – Permanent Mould Casting –Metal mould casting- Continuous casting-Squeeze casting-Vacuum mould casting- Evaporative pattern casting- Ceramic shell casting.

UNIT III ADVANCED WELDING PROCESSES 9

Electron beam welding - laser beam welding - ultrasonic welding processes- Friction stir welding- Explosive welding-Diffusion bonding-High frequency Induction welding- Magnetic

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arc welding- gas metal Welding- Narrow gap welding techniques- Plasma key hole welding.

UNIT IV ADVANCED METAL FORMING PROCESSES 9

High energy rate forming process- Electro-magnetic forming, Explosive Forming- Electro-hydraulic forming- Stretch forming- Contour roll forming - High energy rate forming - Magnetic Pulse forming - Electro hydraulic forming - Cold Roll Forming, Incremental Press Forming and Millipede forming..

UNIT V MICRO AND NANO MATERIALS, ELECTRICAL PARTS MACHINING PROCESSES 9

Micro machining centers- E-Manufacturing, nanotechnology, and micromachining, High speed Machining Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, PCB Manufacturing, surface mount technology.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Explain the appropriate advanced unconventional machining processes based upon applications	Understand
CO2: Explain the importance of advanced casting processes for the production of complex engineering components.	Understand
CO3: Design the welding processes for applying suitable standards and procedures as per the control plan for the required specification.	Apply
CO4: Select suitable forming processes and procedures to manufacture intricate, complex shape parts and difficult to machine materials.	Apply
CO5: Explain appropriate manufacturing processes for micro and nano materials and electrical and electronics component production.	Understand

Text Book(s):

T1. E. P. DeGarmo, J. T Black, R. A. Kohser "Materials and Processes in Manufacturing" (8th Edition), Prentice Hall of India, New Delhi (ISBN 0-02-978760).

T2. Ghosh, and A. K. Mallik "Manufacturing Science", Affiliated East-West Press Pvt. Ltd. New Delhi.

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T3. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Process for Engineering Materials", 5th Edition, Pearson Education, 2014.

Reference(s):

R1. V. K. Jain, “Advanced Machining Processes”, 1st edition, Allied Publishers Pvt. Ltd, 2007. ISBN: 978-8177642940.

R2. H. Abdel and G. El-Hofy, “Advanced Machining Processes: Nontraditional and Hybrid Machining Processes”, 1st edition, McGraw-Hill Professional, 2005. ISBN: 978- 0071453349.

R3. G.F. Benedict, “Nontraditional Machining Processes”, 1st edition, Marcel Dekker Inc. 2002.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	2	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	2	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	2	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	2	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	2	-

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code: 19MEEC1012</td><td colspan="3">Course Title: LEAN MANUFACTURING
(Common to AU & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Manufacturing Processes

Course Objectives:

The course is intended to:

1. Understand the Lean Manufacturing principles.
2. Apply various Lean tools.
3. Apply value stream management.
4. Apply the lean principles in manufacturing and service industries.
5. Evaluate various lean metrics.

UNIT I INTRODUCTION TO LEAN MANUFACTURING 7

Manufacturing systems-Types-Ford Production System, Lean Manufacturing Paradigm-History of Lean Manufacturing-Traditional Vs Lean Manufacturing, TQM vs. Lean, Toyota Production System. Lean Principles-Value Added Activities-Non-Value Added Activities-Necessary Non-Value added Activities- 3Ms-Muda, Mura and Muri-Types of wastes, Lean objectives-Need for lean manufacturing.

UNIT II LEAN TOOLS AND METHODOLOGIES 9

Problem solving tools-Cause and Effect Diagram, Pareto analysis, FMEA, Work cell and equipment management tools- Process Mapping, Spaghetti diagram, U shaped Layout, Poke Yoke, Kanban , Andon, SMED, One Piece Flow , GenchiGenbutsu, Milk run , Visual workplace, Quality at the source Methodologies-Pillars of Lean Manufacturing-Just in Time, Jidoka, 5S, TPM, Six sigma, DFMA, Kaizen.

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UNIT III VALUE STREAM MANAGEMENT 10

Value stream Mapping-Value stream icons-Road map-Current State, Future State-Demand stage-Market Dynamics, Customer Demand; PQ Analysis; PR Analysis; Takt Time; Pitch; Finished Goods Stock, Cycle Stock Buffer Stock; Safety Stock-Flow Stage-Continuous flow, work cells, Line balancing, Standardized work, Quick change over, Autonomous maintenance, In process Super markets, Kanban systems, FIFO Lanes, Production Scheduling, Leveling Stage-Paced Withdrawal, Heijunka(Load Leveling), Heijunka Box, The Runner-a Case Study.

UNIT IV LEAN IMPLEMENTATION 10

Training Stage-Management Commitment, Identify the value stream manager/Champion and core Implementation team Members, Training of team members, Planning stage-Customer Focus, Go to the floor, Hosin Planning, Brain storming, Prepare Tree Diagram, Select the cross functional team, Prepare project plan, Improvement stage-Production and Productivity-Operator, Process, Machinery and Equipment, Work place Organization, Inventory management, Planning and Procurement of Materials, A case study on Lean implementation in manufacturing and service industries.

UNIT V LEAN METRICS 9

Lean Metrics-the fundamentals, steps in identifying Lean Metrics, WIP inventory, Total Product cycle time, Total value stream lead time, On time delivery, Defective PPM, Uptime, OEE, Throughput rate, Through put yield, Utilization rate, Lean Manufacturing assessment-Radar Chart- a case study.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the Lean Manufacturing principles such as -Value Added Activities-Non-Value Added Activities-Necessary Non-Value added Activities- 3Ms-Muda, Mura and Muri to eliminate the waste	Understand
CO2: Design manufacturing solutions based on various Lean tools and methodologies such as Process Mapping, Spaghetti diagram, U shaped Layout, Poke Yoke, Kanban , Andon, SMED, One Piece Flow .	Apply
CO3: Prepare value stream maps such Current state, Future state mapping, Standardized work, Quick change over, Autonomous maintenance to eliminate the non value added activities.	Understand
CO4: Design manufacturing solutions for manufacturing and service industries based on Hosin Planning.	Apply
CO5: Compare various lean metrics such as Lead time, Cycle Time, through put time, PPM, Uptime, OEE, Throughput rate, Through put yield for Lean assessment.	Understand

Text Book(s):

T1. Don Tapping, Tom Luyster, and Tom Shuker, "Value stream Management Eight steps to planning", Mapping and sustaining Lean Improvements in Administrative Areas, Taylor & Francis ,2018.

T2. N.Gopalakrishnan, "Simplified Lean Manufacture Elements, Rules", Tools and implementation, PHI Learning, New Delhi, 2010.

Reference(s):

R1. James P. Womack, Daniel T Jones, Daniel Ross "The Machine That Change the world", Free Press trade paperback edition, U.S.A, 2007.

R2. Ronald G. Askin& Jeffrey B.Goldberg, "Design and Analysis of Lean Production Systems",2003, John Wiley & Sons,2003.

R3. Rother M. and Shook J, "Learning to See: Value Stream Mapping to Add Value and Eliminate Muda" , Lean Enterprise Institute, Brookline, MA,1999.

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Web References:

1. https:// www.learning –to-see.co.uk.
2. https://www.lean.org.
3. https://www.leanproduction.com.

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1010	Course Title: MANUFACTURING SYSTEMS ENGINEERING		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Pre-requisites:

- Manufacturing Processes

Course Objectives:

The course is intended to:

1. Explain the components of manufacturing systems engineering.
2. Identify seven types of wastes.
3. Describe flow production and level production using "JIT".
4. Differentiate appropriate performance metrics.
5. Develop cell level standardized work procedures.

UNIT I PRODUCTION SYSTEM 7

Generalized model of production systems- types of production systems and its impact on system design- lifecycle concepts of production systems- Basic IE tools.

UNIT II PRODUCTION AND JIT PRODUCTION MANAGEMENT 8

Approach to production management- Introduction & overview of JIT production system-Relations among sales price- cost and profit, ten arguments against the JIT production revolution- ”wastology”- types of waste- waste removal and secrets for not creating waste-the “5s” approach – theory of constrains.

UNIT III FLOW PRODUCTION AND MULTI PROCESS OPERATION 10

Introduction to flow production- principle of flow analysis- flow production within factories & between factories- precautions and procedures for developing multi-process operations-

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level production,-various ways to create production schedules- leveling techniques- difference between shish-kabob production and level production.

UNIT IV BASICS OF KANBAN, KAIZEN AND JIDOKA 10

Differences between kanban and conventional systems -functions and rules of kanban- variety and quantity of kanban, administration of kanban, visual controls – andons, changeover improvement kaizen- seven rules for improving changeover-

steps toward jidoka -difference between jidoka and automation - functions of jidoka, extension of jidoka to the assembly lines - labour cost reduction steps.

UNIT V STANDARD OPERATIONS, MAINTENANCE AND SAFETY 10

Overview of standard operation, establishment of standard operation and charts- overall plan for achieving zero defects- the poka-yoke system- types of maintenance- CCO -three lessons in maintenance- importance of safety- waste related forms -5s forms.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the components and characteristics of manufacturing systems engineering.	Understand
CO2: Identify seven types of waste through value added and non value added analysis.	Understand
CO3: Describe flow production and level production using "JIT" tools (Kanban, flow, level, synchronization).	Understand
CO4: Differentiate appropriate performance metrics of different manufacturing systems.	Understand
CO5: Develop cell level standardized work procedures by applying concepts of JIT.	Apply

Text Book(s):

T1. Chase, Jacobs, Aquilano, “Production and Operations Management” 8th Edition, Tata McGraw Hill CompaniesInc, 2008.

T2. PaneerSelvam R “Production and Operations Management” Prentice Hall of India, 2012.

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T3. Hiroyuki Hirano, “JIT Implementation Manual”, English Translation Copy Right Productivity Press, 2009.

Reference Book(s):

R1. Kotsundo Hitomis’s, “Manufacturing System Engineering”, Second Edition, Taylor & Francis, 1996.

R2. Adam Jr, Everette E. and Ebert, “Production and Operations Management-Concepts; Models and Behavior” 5th Edition, Prentice-Hall of India, 2012.

R3. Chary “Theory and Problems in Production and Operations Management” Tata Mc-Hraw Hill, 2009.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1027	Course Title: SUSTAINABLE MANUFACTURING		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

OBJECTIVES

1.To be acquainted with sustainability in manufacturing and its evaluation.

2.To provide knowledge in environment and social sustainability.

3.To provide the student with the knowledge of strategy to achieve sustainability.

4.To familiarize with trends in sustainable operations.

5.To create awareness in current sustainable practices in manufacturing industry.

UNIT I ECONOMIC SUSTAINABILITY 9

Industrial Revolution-Economic sustainability: globalization and international issues-Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability -Assessments of economic sustainability

UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9

Social sustainability – Introduction-Work management -Human rights - Societal commitment-Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources - Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

UNIT III SUSTAINABILITY PRACTICES 9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements –Cost and time model

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UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs

UNIT V TRENDS IN SUSTAINABLE OPERATIONS 9

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Discuss the importance of economic sustainability	Understand
CO2:Describe the importance of sustainable practices.	Understand
CO3:Identify drivers and barriers for the given conditions.	Understand
CO4:Formulate strategy in sustainable manufacturing	Understand
CO5:Plan for sustainable operation of industry with environmental, cost consciousness.	Understand

Text Book(s):

1.Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.

2.Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.

3.Jovane F., Ęmper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer,2009, United States, ISBN 978-3-540-77011-4.

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Reference Book(s):

1. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
2. SeligerG., “Sustainable Manufacturing: Shaping Global Value Creation”, pringer,United States, 2012, ISBN 978-3-642-27289-9.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td colspan="2">Course Code: 19MEEC1014</td><td colspan="3">Course Title: ENGINEERING ECONOMICS AND COST ANALYSIS
(Common to AU & ME)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Manufacturing Technology

Course Objective

The course is intended to

1. Calculate the breakeven point.
2. Application of interest formula.
3. Comparison of economic alternatives.
4. Replacement analysis of equipment.
5. Calculate depreciation of an equipment.

UNIT I INTRODUCTION TO ECONOMICS 8

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics - Elements of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis

UNIT II VALUE ENGINEERING 10

Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods with problems.

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UNIT III CASH FLOW MANAGEMENT 9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT IV REPLACEMENT AND MAINTENANCE ANALYSIS 9

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

UNIT V DEPRECIATION 9

Depreciation- Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset. Case study

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Categorize different cost and calculate the breakeven point for a given business situation	Apply
CO2: Apply different interest formulae and their application in decision making process.	Apply
CO3: Evaluate present value, future value and annual worth analysis on one or more economic alternatives.	Apply
CO4: Determine the economic value of an asset and develop a better replacement policy for given equipment.	Apply
CO5: Evaluate the depreciation of equipment per period.	Apply

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Text Book(s):

T1. Panneerselvam R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2014

T2. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2016.

Reference(s):

R1. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010.

R2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2010.

Web References:

1. https://en.wikipedia.org/wiki/Engineering_economics
https://en.wikipedia.org/wiki/Cost%E2%80%93benefit_analysis

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	3	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	3	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	3	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	3	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	3	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEC1008	Course Title: COMPOSITE MATERIALS (Common to AU, MC & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the courses:

- Material Science
- Strength of Materials

Course Objectives

The course is intended to:

1. Explain the properties of matrices and reinforcements.
2. Explain the various types of composite materials.
3. Explain the fabrication and testing of composites.
4. Explain the mechanics and lamination theory of fiber reinforced composites.
5. Explain the load bearing behaviour of composite and composite structures.

UNIT I MATRICES AND REINFORCEMENTS 9

Definition – Functions of a Matrix, desired Properties of a Matrix, Classifications of Matrix - Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.: Role and selection of reinforcement materials, Classifications of Reinforcements/Fibers - Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers etc., Mechanical properties of fibres.

UNIT II TYPES OF COMPOSITES 9

Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

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UNIT III FABRICATION AND TESTING OF COMPOSITES 9

Fabrication methods: hand layup, Autoclave, filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer. Mechanical testing of composites - tensile testing, Compressive testing, Flexural testing, Shear testing and Impact testing.

UNIT IV MECHANICS AND LAMINATION THEORY OF COMPOSITES 9

Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi - Empirical model - Longitudinal Young's modulus-transverse Young's modulus – major Poisson's ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina – laminates – lamination theory, Maximum stress and strain criterion- Tsai-Hill, Tsai-Wu, Inter laminar stresses- Impact resistance- Fracture resistance- Fatigue resistance.

UNIT V COMPOSITE STRUCTURES 9

Fatigue – S-N curves – Fatigue behaviors of CMCs – Fatigue of particle and whisker reinforced composites. Introduction to structures - selection of material, manufacturing and laminate configuration -design of joints - bonded joints - bolted joints - bonded and bolted. Case studies in design and development of composite parts, boats, pressure vessels, automotive parts, aerospace parts, electronics parts and composites for space vehicles.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the properties of matrices and reinforcements	Understand
CO2: Explain the various types of composite materials	Understand
CO3: Explain the fabrication and testing of composites.	Understand
CO4: Explain the mechanics and lamination theory of fiber reinforced composites.	Understand
CO5: Explain the load bearing behavior of composite and composite Structures	Understand

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Text Book(s):

T1. Krishnan K.Chawla, “Composite Materials Science and Engineering”, Springer-Verlag New York, 3rd Edition, 2012.

T2. Mallick, P.K., “Fiber Reinforced Composites: Materials, Manufacturing and Design”, CRC Press; 3rd edition, 2007.

Reference Book(s):

R1. Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”,John Wiley and Sons, New York, 2012.

R2. Gibson, R.F., “Principles of Composite Material Mechanics”, McGraw-Hill, 2011.

R3. Srinivasan K , “Composite Material” Narosa Publication , 2009.

Web References:

1. http://nptel.ac.in/courses/101104010/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1028	Course Title: ENERGY CONSERVATION IN INDUSTRIES		
Course Category:Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives:

At the end of the course, the student is expected to:

1. Conduct energy audit and suggest methodologies for energy savings
2. Suggest methodologies for energy savings in thermal systems
3. Suggest methodologies for energy savings in major industrial utilities
4. Explain the various methods of energy economic analysis
5. Explain the global environmental issues and climate change problems

UNIT I INTRODUCTION & ENERGY AUDIT 12

Energy-Power-Past and Present scenario of World –National Energy consumption data – Environmental aspects associated with energy utilization. Energy Auditing – Need – Types-Methodology - -Role of Energy Managers – Instruments for Energy Auditing, Energy Audit Reporting.

UNIT II ENERGY CONSERVATION IN THERMAL SYSTEMS 9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and energy conservation measures. Steam: Distribution &Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT III ENERGY CONSERVATION IN MAJOR UTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers

UNIT IV ENERGY ECONOMICSAND MANAGEMENT 8

Importance and role of energy management – Energy Economics - Simple payback period, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Life cycle costing.

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UNIT V ENVIRONMENTAL IMPACT AND CLIMATE CHANGE 7

Energy and Environment, Global environmental issues- Acid rain, Ozone layer depletion, Global Warming and climate change, Loss of biodiversity. International agreements: United Nations Framework convention on climate change (UNFCCC), Conference of Parties (COP), The Kyoto Protocol, Clean Development Mechanism (CDM).

Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level
CO1: Describe the methodology of energy auditing and suggest methodologies for energy savings	Understand
CO2: Suggest methodologies for energy savings in thermal systems	Understand
CO3: Suggest methodologies for energy savings in major industrial utilities	Understand
CO4: Explain the various methods of energy economic analysis	Understand
CO5: Describe the global environmental issues and climate change problems	Understand

Text Book(s):

T1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under the Ministry of Power, Government of India, 2004.

Reference(s):

R1. L.C.Witte, P.S.Schmidt, D.R.Brown, Industrial Energy Management and Utilization, Hemisphere Publications, Washington, 1988.

R2. Callaghn P.W., Design and Management of Energy Conservation, Pergamon Press, Oxfore, 1981.

R3. W.R.Murphy and G.Mckay, Energy Management, Butterworths, 2nd Edition, 2009.

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R4. Wayne.C.Turner, Steve Doty, Energy Management Handbook, Sixth Edition, CRC Press, 2006.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

R5. High-3; Medium-2; Low-1

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Course Code: 19MEEN1013	Course Title: POWER PLANT ENGINEERING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Pre-requisites:

- Applied Thermodynamics

Course Objectives:

The course is intended to:

1. Explain the construction and working principle of steam power plant.
2. Explain the working principle of hydroelectric and nuclear power plants.
3. Explain the operation and maintenance of diesel and gas turbine power plant.
4. Explain the working principle of non conventional power plants.
5. Calculate the cost of power generation for various power plants.

UNIT I STEAM POWER PLANT 12

Layout of Steam power plant- Fuel and Ash handling systems - Combustion equipment for burning coal- Mechanical Stokers – Pulveriser – Gas cleaning systems- Electrostatic Precipitator and Mechanical dust collector. Draught – Different types- Surface Condenser and Cooling Towers. Steam Boilers– High Pressure, Super Critical Boilers and Ultra supercritical boilers– Fluidised Bed Boilers, Pollution Control methods.

UNIT II HYDROELECTRIC AND NUCLEAR POWER PLANT 9

Layout of Hydroelectric Power Plant – Essential Elements –Types – Standalone and Pumped storage- Site selection - Indian Scenario.

Nuclear Energy – Fission, Fusion Reaction- Layout of Nuclear power plant-Types of Reactors- Pressurized water , Boiling water , Gas cooled , Fast breeder Reactor- Waste Disposal and safety - site selection- Indian scenario – Recent Developments.

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UNIT III DIESEL AND GAS TURBINE POWER PLANT 9

Layout of Diesel Power Plant -Types and Components - Engine Selection based on Application-Recent developments.

Gas Turbine Power Plant – Layout – Fuels - Gas Turbine Material - Types of Combustion Chambers – Performance Improvement Methods - Reheating, Regeneration, Inter cooling, Combined Cycle Power Plant- Recent developments.

UNIT IV NON-CONVENTIONAL POWER PLANTS 8

Solar Power Plants-Low, Medium and High Temperature Systems -Wind Energy Conversion System-Horizontal and Vertical Wind Turbines –Geo-Thermal Power Plant – Bio Gas Power Plant – MHD - OTEC Systems - Tidal Power Plants.

UNIT V POWER PLANT ECONOMICS 7

Load duration curves - Cost of Electric Energy, Types of Tariffs- Economics of Load Sharing - Comparison of Economics of Various Power Plants. Energy Conservation and Energy Audit in steam power plant - Renovation and Modernization of aged power plants.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the construction and working principle of various subsystem and pollution control methods in a steam power plant	Understand
CO2: Explain the working principle of various components of hydroelectric and various types of nuclear reactor used in nuclear power plant.	Understand
CO3: Describe the various components, working principle and performance improvement methods in diesel and gas turbine power plant	Understand
CO4: Explain the working principle of various types of non conventional power plants viz Solar, Wind, Geothermal, Bio Gas, MHD, OTEC, Tidal	Understand
CO5: Calculate the cost of power generation for various power plant using different types of tariff systems.	Apply

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Text Book(s):

T1. S. C. Arora and S. Domkundwar, "A course in Power Plant Engineering", Dhanpat Rai& Sons, New Delhi, 2008.

T2. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Company Pvt Ltd., New Delhi,2007.

Reference(s):

R1. M. M. EI-Wakil, "Power Plant Technology", Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,1985.

R2. G.R. Nagpal, "Power Plant Engineering", Khanna Publishers, New Delhi, 2002.

R3. G.D. Rai, "Introduction to Power Plant Technology", Khanna Publishers, New Delhi, 1995.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1029	Course Title: GAS DYNAMICS AND SPACE PROPULSION		
Course Category:Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives:

The course is intended to:

1. Understanding the compressible flow concepts and the use of gas tables.
2. Analyzing the compressible flow behaviour in constant area ducts with friction and heat transfer.
3. Analyzing the formation of shock waves and its effect on flow parameters.
4. Understanding the working of different jet engines and their performance parameters.
5. Classifying types of rocket engines, propellants and their performance parameters.

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

UNIT II COMPRESSIBLE FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.

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UNIT IV JET PROPULSION 9

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

UNIT V SPACE PROPULSION 9

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries.

Course Outcomes **Upon completion of this course, the students will be able to:**	**Cognitive Level**
CO1: Describethe compressible flow concepts and the use of gas tables.	Understand
CO2: Calculate the compressible flow behavior in constant area ducts with friction and heat transfer.	Apply
CO3: Calculate the development of shock waves and its effects.	Apply
CO4: Explain the types of jet engines and their performance parameters.	Understand
CO5: Classify types of rocket engines, propellants and their performance parameters.	Understand

Text Book(s):

T1. Anderson, J.D., "Modern Compressible flow", Third Edition, McGraw Hill, 2003.

T2. S.M. Yahya, "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", New Age International (P) Limited, 4th Edition, 2012.

Reference(s):

R1. R. D. Zucker and O Biblarz, "Fundamentals of Gas Dynamics", 2nd edition, Wiley, 2011.

R2. Balachandran, P., "Fundamentals of Compressible Fluid Dynamics", Prentice-Hall of India, 2007.

R3. Radhakrishnan, E., "Gas Dynamics", Printice Hall of India, 2006.

R4. Hill and Peterson, "Mechanics and Thermodynamics of Propulsion", Addison – Wesley, 1965.

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1030	Course Title: COMPUTATIONAL TECHNIQUES FOR FLUID DYNAMICS		
Course Category:Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives:

The course is intended to:

1. Applying the fundamentals of CFD, and developing case specific governing equations.
2. Performing finite difference and finite volume based analysis for steady and transient diffusion problems.
3. Implementing various mathematical schemes under finite volume method for convention diffusion.
4. Solving complex problems in the field of fluid flow and heat transfer with the support of highspeed computers.
5. Applying the various discretization methods, solution procedure and the concept of turbulence modeling.

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations– Continuity, Momentum and Energy equations – Chemical species transport –Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Derivation of finite difference equations– General Methods for first and second order accuracy –Finite volume formulation for steady and transient diffusion problems – Example problems– Use of Finite Difference and Finite Volume methods.

UNIT III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing

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schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Conservativeness, Boundedness, Transportiveness.

UNIT IV FLOW FIELD ANALYSIS **9**

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, SIMPLEalgorithm and its variants – PISO Algorithms.

UNIT V TURBULENCE MODELS AND MESH GENERATION **9**

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models, Mesh Generation and refinement Techniques-software tools.

Course Outcomes **Upon completion of this course, the students will be able to:**	**Cognitive Level**
CO1: Apply the fundamentals of CFD, and develop case specific governing equations	Apply
CO2: Perform finite difference and finite volume based analysis for steady and transient diffusion problems.	Apply
CO3: Implement various mathematical schemes under finite volume method for convention diffusion.	Apply
CO4: Solve complex problems in the field of fluid flow and heat transfer with the support of highspeed computers.	Apply
CO5: Apply the various discretization methods, solution procedure and the concept of turbulence modeling.	Apply

Text Book(s):

1. Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics":The finite volume Method, Pearson Education, 2014
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill,1998.

Reference(s):

1. John. F. Wendt, "Computational Fluid Dynamics – An Introduction", Springer, 2013.

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2. K.Muralidhar&T.Sundararajan, Computational Fluid Flow and Heat Transfer, NaroraPublishing House, 1994.
3. Suhas V, Patankar, “Numerical Heat transfer and Fluid flow”, Taylor & Francis, 2009.
4. Uriel Frisch, Turbulence, Cambridge University Press, 1999.
5. YogeshJaluria& Kenneth E. Torrance, “Computational Heat Transfer”, CRC press, 2002.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1031	Course Title: ENERGY STORAGE DEVICES		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Discuss the need and identify the suitable energy storage devices
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries
4. Discuss the storage of renewable energies and management systems
5. Explain the need for other energy devices and their scope

UNIT I INTRODUCTION 9

Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical–Thermal - Chemical– Electrochemical – Electrical - Other alternative energy storage technologies –Efficiency and Comparison.

UNIT II ENERGY STORAGE SYSTEMS 9

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation – Thermo-chemical systems – Batteries – Types-Charging and Discharging – Battery testing and performance..

UNIT III MOBILE AND HYBRID ENERGY STORAGE SYSTEMS 9

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standbysupplies – V2G and G2V technologies – HESS.

UNIT IV RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT 9

Storage of Renewable Energy Systems –Solar Energy – Wind Energy – Energy Storage in Micro grid–Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Auditand Management

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UNIT V OTHER ENERGY DEVICES 9

Superconducting Magnetic Energy Storage (SMES), Supercapacitors – MHD Power generation – Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC, SOFC,MCFC and Biofuel Cells – Biogas Storage.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Discuss the need and identify the suitable energy storage devices for applications.	Understand
CO2: Explain the working of various energy storage devices and their importance.	Understand
CO3: Explain the basic characteristics of batteries for mobile and hybrid systems.	Understand
CO4: Discuss the storage of renewable energies and management systems.	Understand
CO5: Explain the need for other energy devices and their scope for applications.	Understand

Text Book(s):

T1. Rober Huggins, "Energy Storage: Fundamentals, Materials and Applications", 2 nd Edition,Springer, 2015.

T2. Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, 2001

Reference Book(s):

R1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in PowerSystems" Wiley Publication, 2016.

R2. Ru-Shiliu, Leizhang, Sueliang Sun, "Electrochemical Technologies for Energy Storage andConversion", Wiley Publications, 2012.

R3. Aulice Scibioh M. and Viswanathan B, "Fuel Cells – principles and applications', UniversityPress(India), 2006.

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1015	Course Title: SOLAR AND WIND ENERGY ENGINEERING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Applied Thermodynamics

Course Objectives

The course is intended to:

1. Identify the availability of solar radiation.
2. Describe main features and operation of solar thermal systems.
3. Explain the working principle of solar-photovoltaic systems.
4. Acquire the knowledge of wind turbine aerodynamics.
5. Describe main features and operation of various wind turbines and their energy conversions.

UNIT I SOLAR ENERGY RADIATION AND SOLAR THERMAL COLLECTORS 9

Solar radiation availability - radiation measurement – transmittance - absorptance – Basic earth sun angles - estimation of average solar radiation, radiation on tilted surface - Flat plate collectors - heat transfer correlations - collector efficiency - heat balance – absorber plate – types - selective surfaces. Solar water heaters - types- their performance. Solar driers – types – heat transfer - performance of solar dryers – agro industrial applications.

UNIT II SOLAR CONCENTRATING COLLECTORS 9

Concentrating collectors – types – reflectors - solar thermal power stations – principle and applications - Solar energy storage systems – thermal - sensible and latent heat, chemical, electrical, electro-magnetic energy storage – selection of materials for energy storage - Solar distillation – application - Solar stills - types - Solar pond - performance – characteristics - applications – Solar refrigeration.

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UNIT III SOLAR PV TECHNOLOGY 9

Solar photovoltaic technology –introduction – solar cell basics – Types of solar cells and modules – encapsulation – Design of solar PV system – load estimation - batteries – invertors – operation - system controls. Standalone and grid connected systems - PV powered water pumping - Hybrid system - Solar technologies in green buildings.

UNIT IV WIND ENERGY 9

Nature of the wind – power in the wind – factors influencing wind – wind energy potential and installation in India- wind speed monitoring - wind resource assessment - wind power laws - velocity and power duration curves - Betz limit - site selection.

UNIT V WIND MILL TYPES AND APPLICATIONS 9

Wind energy conversion devices - classification, characteristics, applications – Design of horizontal axis wind mill rotor diameter - Wind energy storage - wind farms - wheeling and banking - testing and certification procedures. Water pumping - Hybrid systems – Wind mill safety and environmental aspects.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Identify the availability of solar radiation in different places and operation of solar thermal systems.	Understand
CO2: Describe main features and application of solar collectors.	Understand
CO3: Explain the working principle of solar-photovoltaic systems.	Understand
CO4: Acquire the knowledge of wind energy and its assessment.	Understand
CO5: Describe main features and operation of various wind turbines and their energy conversions.	Understand

Text Book(s):

T1. Rai., G.D. “Solar Energy Utilization” Khanna publishers, New Delhi, 2012.

T2. Solanki, C.S. “Renewable Energy Technologies: A Practical guide for beginners**”.** PHI learning Pvt. Ltd, New Delhi. 2008.

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Reference(s):

R1. Wind Energy Engineering, Pramod Jain, McGraw Hill Education, New York, 2nd Edition, 2010.

R2. Rajput. R.K. "Non- Conventional Energy Sources and Utilization", S. Chand & Company Pvt. Ltd, New Delhi, 2013.

R3. Rao.S and B.B. Parulekar. "Energy Technology – Non conventional, Renewable and Conventional". Khanna Publishers, Delhi, 2000.

Web References:

1. http://www.icebookshop.com
2. http://nptel.ac.in/courses/112107143/40

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1032	Course Title: ALTERNATIVE FUELS AND ENERGY SYSTEMS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Power plant Engineering
- Thermal Engineering

Course Objectives

The course is intended to:

1. Describe the different types of alternate energy sources and fuels
2. Explain the suitability of ethanol and methanol as automotive fuel.
3. Explain the suitability of LPG, CNG, Hydrogen and Bio gas as IC engine fuels.
4. Explain the Performance and emission characteristics of vegetable oils
5. Explain the layout and working principle of electric, hybrid, fuel cell and solar cars.

UNIT I INTRODUCTION 9

Alternate energy sources

Introduction to alternate energy sources, Man and energy, energy forms, Need for alternate sources of energy, availability, Merits and demerits. Scope of alternate energy sources in India, Energy management, Global Energy Issues, National & State Level Energy Issues

Alternate fuels

Need for alternate fuel, Availability and properties of alternate fuels, General use of alcohols LPG, hydrogen, ammonia, CNG and LNG, vegetable oils, biogas, EV, hybrid vehicles, Fuel cells and solar cells ,Merits and demerits of alternate fuels,

UNIT II ALCOHOLS 9

Properties as engine fuels, alcohols and gasoline blends, Performance in SI engine using methanol blends, Performance in SI engine using gasoline blends, Combustion characteristics in CI engine, Emission characteristics, DME, DEE properties, Performance analysis of DME, DEE, Performance in SI engine, Performance in CI engine

UNIT III NATURAL GAS, LPG, HYDROGENANDBIOGAS 9

Availability of CNG, properties, Modification required to be done in engines for CNG Performance and emission characteristics of CNG, Performance and emission characteristics of LPG, LPG in SI and CI engines, Hydrogen storage
and handling, Performance and safety aspects. Biogas, Properties, production methods, Performance and emission characteristics

UNIT IV VEGETABLEOILS 9

Various vegetable oils for engines, Etherification process in vegetable oils, Performance of engines using vegetable oils, Performance and emission characteristics of a engine using vegetable oils, Bio-diesel and its characteristics

UNIT V ELECTRIC, HYBRID, FUEL CELL AND SOLARCARS 9

Layout of electric vehicles, Advantages and limitations of electric vehicles, Specifications and system components, Electronic control system, High energy and power density batteries, Hybrid vehicles, Fuel cell vehicles, Solar powered vehicles.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Explain the different types of alternate energy sources, alternate fuels and the properties and suitability of Alcohol, LPG, CNG, Hydrogen, Bio gas and Vegetable oils as automotive fuels	Understand
CO2:Explain the properties, suitability, engine modifications required,performance and emission characteristics of IC engines using ethanol and methanol as fuel.	Understand

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CO3:Explain the properties, suitability, engine modifications required, performance and emission characteristics of IC engines using LPG, CNG, Hydrogen and Bio gas as IC engine fuels.	Understand
CO4:Explain the properties, suitability, engine modifications required, performance and emission characteristics of vegetable oil as IC engine fuel.	Understand
CO5:Explain the layout and working principle of electric, hybrid, fuel cell and solar Cars with their merits and demerits.	Understand

Text Books

1. Richard.L.Bechtold, "Alternative Fuels Guide Book", SAE, 1997.
2. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.

References

1. Nagpal, "Power Plant Engineering", Khanna Publishers, 1991.
2. MaheswarDayal, "Energy today & tomorrow", I & B Horishr India, 1982.
3. "Alcohols as motor fuels progress in technology", Series No.19, SAE Publication,1980

Web References

- https://en.wikipedia.org/wiki/Alternative_fuel

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

- High-3; Medium-2; Low-1

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Course Code: 19MEEN1014	Course Title: REFRIGERATION AND AIR-CONDITIONING		
Course Category:Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to:

1. Calculate the performance of vapor compression refrigeration cycles.
2. Explain the various components of vapor compression refrigeration system.
3. Explain the various air conditioning systems.
4. Explain the applications of refrigeration and air conditioning systems.
5. Explain the refrigerant charging procedure, leakage detection and various control methods.

UNIT I REFRIGERATION 9

Thermodynamic principles of refrigeration – Types of Refrigeration Systems – Vapour compression refrigeration System, Ts and P-H diagrams, Performance calculation –

Vapor Absorption System: Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration, Thermo ElectricRefrigeration

Refrigerants: Primary& secondary refrigerants, Nomenclature of Refrigerants, Properties and selection – Environment friendly alternatives.

UNIT II COMPONENTS OF REFRIGERATION SYSTEM 9

Refrigerant compressors - reciprocating, rotary and centrifugal compressors, evaporators - flooded, dry expansion, shell and tube and double pipe evaporators, condensers - air cooled, water cooled and evaporative condensers, expansion devices - automatic, capillary tube and thermostatic expansion valve.

UNIT III AIR CONDITIONING SYSTEM AND ITS COMPONENTS 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams. Different types of Air Conditioner- Room/Window, Central Air Conditioner.

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UNIT IV AIR CONDITIONING LOAD ESTIMATION AND ITS APPLICATION 10

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Food Preservation, Food Storage & Distribution, LNG – Ice Manufacturing Plant – Solar Air Conditioning, – Automobile air conditioning, Refrigerated trucks.

UNIT V INSTALLATION AND SERVICING 8

Air distribution systems - Study of different types of duct systems - Charging of refrigerant - Servicing of air-conditioning, – Safety procedures, Leak detection procedures- Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors - Automatic Dew point recorder, Actuators & Safety controls.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Calculate the performance of vapor compression refrigeration cycles.	Apply
CO2: Explain the various components of vapor compression refrigeration system viz. evaporator, compressor, condenser and expansion valve.	Understand
CO3: Explain the various air conditioning system using psychrometric concepts.	Understand
CO4: Explain various air conditioning system load calculation and the applications of refrigeration and air conditioning systems viz. food preservation, automobile air conditioning, solar air conditioning.	Understand
CO5: Explain the refrigerant charging procedure, leakage detection and various control methods.	Understand

Text Book(s):

T1. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, 2015.

T2. Arora. C.P., "Refrigeration and Air conditioning", 3rd edition. Tata McGraw-Hill, 2017.

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Reference(s):

R1. Dossat, R.J. "Principles of Refrigeration", Prentice-Hall, 2013.R.S.Khurmi, J.K.Gupta."Textbook of Refrigeration and Air-conditioning"S.Chand, 2nd Edition, 2006.

R2. ASHRAE 2017 Hand book (Fundamentals &Equipments).

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td colspan="2">Course Code: 19MEEC1011</td><td colspan="3">Course Title: NON-DESTRUCTIVE TESTING METHODS
(Common to AU, MC & ME)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
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Prerequisites

The student should have undergone the course(s):

- Metrology and Measurements.

Course Objectives

The course is intended to:

1. Explain the testing procedure for Visual Inspection and Eddy Current Testing Method.
2. Explain testing procedure for Magnetic Particle Testing Method.
3. Explain testing procedure for Liquid Penetrant Testing Method.
4. Plan inspection sequence for Ultrasonic Testing Method.
5. Plan inspection sequence for Radiographic Testing Method.

UNIT I VISUAL INSPECTION AND EDDY CURRENT TESTING METHOD 9

Scope and advantages of NDT-Compare NDT with DT-Principle of Visual Inspection theory- Optical aids used for Visual Inspection-Microscope, Boroscope, Endoscope, Flexiscope, Telescope and Hollography- Principles of Eddy Current Theory-surface mounted coils-Encircling coils-types of Probes-Eddy current sensing Probes-Flux leakage sensing Probes-Eddy Current Techniques, Advanced Eddy Current Techniques-applications, Limitations and standards.

UNIT II MAGNETIC PARTICLE TESTING METHOD 9

Basic Principle of magnetic particle testing(MPT)-induced magnetic fields-circular and longitudinal fields-Hysteresis curve-magnetic flux strips and coils-residual fields and demagnetization-MPT techniques-magnetization using a permanent magnet, magnetization using a Electro magnet, contact current flow method, wet and dry particle inspection methods, remote magnetic particle inspection, probe power inspection, light weight UV lamps inspection, semi automatic inspection, applications and limitations of MPT.

UNIT III LIQUID PENETRANT TESTING METHOD 9

Physical properties of liquid penetrant-penetrant testing materials-penetrants, cleaners, emlusifiers developers, lint free cloth-Basic Principle, applications and limitations of liquid penetrant testing(LPT)-different LPT methods-Post-Emulsification

Fluorescent penetrant process, Reverse Fluorescent Dye penetrant process, Visible Dye penetrant process, Water-Emulsification visible Dye penetrant process, solvent clean visible Dye penetrant process.

UNIT IV ULTRASONIC TESTING METHOD 9

Basic properties of sound beam-sound waves-velocity of ultrasonic waves, Acoustic Impedance behaviour of ultrasonic waves-ultrasonic transducers-characteristics of ultrasonic beam, Flaw sensitivity, Beam divergence, Attenuation-Principle of ultrasonic testing methods, applications and limitations-Ultrasonic testing method-normal incident pulse echo inspection method, normal incident through transmission testing method, angle beam pulse echo inspection method.

UNIT V RADIOGRAPHIC TESTING METHOD 9

Basic Principle of Radiography-Electromagnetic radiation sources-X ray source, Gamma ray source-properties of X and Gamma rays-Radiographic Imaging-Geometrical factors-radiographic film-film density-Radiographic sensitivity- Penetrameter-Radiographic Inspection Techniques-single wall single image technique, wall penetration technique, Latitude technique-Applications and Limitations of Radiographic Inspection Techniques.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the testing procedure for Visual Inspection and Eddy Current Testing Method in Quality Assurance.	Understand
CO2: Explain testing procedure for Magnetic Particle Testing Method for Quality Assurance.	Understand
CO3: Explain testing procedure for Liquid Reentrant Testing Method for Quality Assurance.	Understand
CO4: Plan inspection sequence for Ultrasonic Testing Method for Quality Assurance.	Understand
CO5: Plan inspection sequence for Radiographic Testing Method for Quality Assurance.	Understand

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Text Book(s):

T1. Baldev Raj, T.Jayakumar, M.Thavasimuthu,“Practical Non-Destructive Testing”, Narosa Publishing House, 2009.

T2. J Prasad, C G K Nair, “Non-Destructive Testing and Evaluation of Materials”, Tata McGraw-HillEducation Private Limited, 2003.

Reference(s):

R1. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.

R2. American Metals Society, “Non-Destructive Examination and Quality Control”, Metals Hand Book, Vol.17, 9th Edition, Metals Park, 1989.

R3. Paul Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition,New Jersey,2005.

Web References:

1. https://www.nde-ed.org/index_flash.htm
2. http:// http://117.55.241.6/library/E-Books/NDT%20Notes.pdf
3. http:// www.slideshare.net/ndtindia123/introduction-uses-of-non-destructive-testing-24377016
4. http:// www.eis.hu.edu.jo/ACUploads/10526/Ultrasonic%20Testing.pdf
5. http://www.hse.gov.uk/comah/sragtech/ndt2.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1033	Course Title: GEOMETRIC DIMENSIONING & TOLERANCING FOR MECHANICAL DESIGN		
Course Category: Professonal Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks: 100

Prerequisites:

- Engineering drawing
- Computer Aided Modeling
- Engineering Metrology

Course Objectives:

At the end of the course the students will be able to

1. Understand the basic concepts and symbols in GD & T
2. Understand the GD&T Modifiers and Datum
3. Understand the form and orientation tolerances of design with applications
4. Understand the profile, location and runout tolerances of design
5. Understand the tolerance and surface texture of design

UNIT I BASIC CONCEPTS AND FORM TOLERANCES 9

Reasons to use GD&T- ASME Y 14.5 standard –Conventional vs Advanced tolerancing methods – use of basic dimensions . Feature size: Material condition of feature of size – Individual feature of size – Degree of freedom. Symbology & Datum - multiple Datum Features.

UNIT II FEATURE CONTROL FRAME , DATUM AND DATUM FEATURES 9

Feature control frame- Rule 1 and Rule 2 of GD&T. Modifiers – use of MMC, LMC, RFS, VC, RC. Size control form – external feature – internal feature – Taylor principle.

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Datum – Applications of datum, Datum feature selection, Datum feature identification, Inclined datum features, Cylindrical datum features.

UNIT III FORM AND ORIENTATION TOLERANCE 9

Tolerances of Form – Flatness, straightness, Circularity and Cylindricity. Tolerances zone, Applications and Inspection methodology for form tolerance. Tolerances of Orientation – Parallelism, Perpendicularity, Angularity, Tolerances zone, Applications and Inspection methodology for Orientation tolerance.

UNIT IV PROFILE, LOCATION & RUNOUT TOLERANCE 9

Line and surface profile – profile as general requirement – unequally disposed profile tolerance – unilateral profile tolerance – tolerance zones.Tolerances of Location – Position, symmetry and concentricity – composite position tolerancing – projected tolerance zone . Applications and Inspection methodology for location tolerance.Tolerances of Runout - Circular runout, Total runout – Measurement of runout.

UNIT V TOLERANCE ANALYSIS & SURFACE TEXTURE 9

Tolerance Analysis – Tolerance Stackup – Worst case and Statistical tolerance analysis. Surface Texture – Definitions - Surface texture symbols and interpretation - Types of surfaces and Lays -Measurement methods - 3D Surface Roughness Measurement.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Understand the basic concepts and symbols in GD & T	Understand
CO2: Understand the GD&T Modifiers and Datum	Understand
CO3: Understand the form and orientation tolerances of design with applications	Understand
CO4: Understand the profile, location and runout tolerances of design	Understand
CO5: Understand the tolerance and surface texture of design	Understand

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Text Book(s):

1. James D Meadows, “Geometric Dimensioning and Tolerancing”, Marcel Dekker, Inc

2. P S Gill, “Geometric Dimensioning and Tolerancing”, S K Kataria & sons.

Reference(s):

1. Bryan R Fischer, “Mechanical Tolerance stackup analysis”, CRC press.

2. Gene R. Cogorno, “Geometric Dimensioning and Tolerancing for Mechanical Design”, McGraw – Hill

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1011	**Course Title: OPERATIONS RESEARCH**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the course(s):

- Numerical methods

Course Objectives

The course is intended to:

1. Solve linear programming problems.
2. Select the optimal solution for transportation and assignment problems.
3. Calculate EOQ and EBQ for manufacturing and purchase models.
4. Select critical paths using CPM and PERT.
5. Select the replacement policy and shortest queuing time.

.UNIT I LINEAR PROGRAMMING 9

Introduction - Formulation of linear programming models – Assumptions-Graphical solution procedure – solving LPP using simplex algorithm – Degeneracy, Revised Simplex Method Duality theory - Interpretation of dual variables- Primal Dual Relationships – Role of duality in sensitivity analysis - Dual simplex method.

UNIT II TRANSPORTATION & ASSIGNMENT MODELS 9

Transportation problems, transportation simplex method– Assignment problems, Hungarian method- LP formulation of transportation and Assignment networks- Traveling sales man problem

UNIT III INVENTORY MODELS 9

Purchase model with no shortages – manufacturing model with no shortage – Purchase model with shortage – Manufacturing model with shortages –model with price breaks.

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UNIT IV NETWORK MODELS **9**

Maximal flow problem – Shortest route problem – Minimal spanning tree problem - Project networks, CPM, PERT, Crashing of networks- L P model for crashing , project costing and control.

UNIT V QUEUING AND REPLACEMENT MODELS **9**

Queuing theory terminology – Single server, multi server, Limited queue capacity – applications – Markov chains. Replacement models – Money value, present worth factor and discount rate.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Solve linear programming problems with simplex and graphical methods after formulation and assumption of required parameters.	Apply
CO2: Select the optimal solution for transportation and assignment problems, based on cost, using Northwest, Least Cost, Vogals Approximation and Hungarian methods.	Apply
CO3: Calculate EOQ and EBQ for manufacturing and purchase models operating with or without shortage.	Apply
CO4: Select critical paths using CPM and PERT in projects based on minimum duration of activities	Apply
CO5: Select the replacement policy and shortest queuing time based on economic cost for various replacement and queuing models. them in domain specific situations.	Apply

Text Book(s):

T1. Hillier and Lieberman “Introduction to Operations Research”, TMH, 2015.

T2. R.Panneerselvam, “Operations Research”, PHI, 2006.

Reference(s):

R1. Philips, Ravindran and Solberg, “Operations Research”, John Wiley,2002.

R2. Hamdy A Taha, “Operations Research – An Introduction”, Prentice Hall India,2003.

R3. Ronald L Rardin, “Optimization in Operations Research”, Pearson, 2003.

Web References:

1. http://nptel.ac.in/courses/112106134/1
2. http://www.mit.edu/~orc/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEN1012	Course Title: TOTAL PRODUCTIVE MAINTENANCE		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Pre-requisites:

- Manufacturing Processes

Course Objectives:

The course is intended to:

1. Describe modern maintenance concepts and practices.
2. Apply analytical tools in maintenance management.
3. Apply Reliability Centered Maintenance for industrial systems.
4. Illustrate TPM and global trends in maintenance management.
5. Demonstrate simple instruments used for condition monitoring.

UNIT I MODERN MAINTENANCE CONCEPTS AND PRACTICES 9

Maintenance definition –Maintenance management – Maintenance Concepts: Objectives, Organization and Functions of Maintenance, Maintenance strategies, Types of Maintenance – Maintenance systems – (Planned, Unplanned / Breakdown, Corrective, Opportunistic, Routine, Preventive, Predictive, Condition based maintenance systems),Maintenance planning and scheduling, Maintenance Logistics, Human factors in Maintenance and Staffing methods, Maintenance manuals, Maintenance costs

UNIT II ANALYTICAL TOOLS IN MAINTENANCE MANAGEMENT 9

Failure Data Analysis, MTBF,MTTF, Useful life-Survival curves, Repair time, Breakdown time distributions- Poisson’s, Normal, Exponential, Availability, Reliability, Maintainability, Maintainability prediction – System effectiveness- Overhaul / Repair / Replace maintenance policy, Queuing applications, simulation, spare parts management, Replacement Decisions: Optimal interval between preventive replacements, Overall Equipment Effectiveness

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UNIT III RELIABILITY CENTERED MAINTENANCE 9

Reliability Centered Maintenance (RCM), Objectives and function, Steps in RCM implementation, steps in RCM analysis, System selection, Tero technology – RCM effectiveness indicators, RCM tasks Proactive Maintenance, Reliability models –
System reliability- Series, Parallel and mixed configuration, System reliability determination; Reliability improvement, Scheduled restoration and scheduled
discard, The P-F interval and P-F curves, linear as non linear PF curves , Default actions, RCM Decision diagrams.

UNIT IV TPM AND GLOBAL TRENDS 9

Concept of TPM, Characteristics of TPM, Zero breakdown concepts, Zero Defects and TPM, FMECA – Maintainability prediction– Design for maintainability, Maximizing equipment effectiveness, Autonomous maintenance program, Five pillars of TPM, TPM Small group activities. Implementing TPM.Philosophy / Indications of TPM. TPM Development - Preparation phase, Master Plan, Initiatives, Promotion, Planning, Organization, Awareness, Training, Establishment of basic policies and goals, TPM organization, Implementation phase; Consolidation phase. Measuring TPM effectiveness: Measuring TPM effectiveness Indicators, Plant effectiveness and Measuring; TPM Benefits and Global trend

UNIT V CONDITION MONITORING IN MAINTENANCE 9

Condition Based Maintenance: Machine signatures, Signature Analysis-MMIS Expert systems, Temperature noise, vibration and wear particle analysis, on line and off line techniques. Online Monitoring Condition Monitoring Techniques, Vibration Monitoring and Signature Analysis. Wear Debris Monitoring, Maintenance Management Information System, Expert systems, Corrosion Monitoring and Control, Case Studies in Maintenance, Measurement and benchmarking of performance, MIS for maintenance.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Describe modern maintenance concepts and practices	Understand
CO2: Apply analytical tools in maintenance management	Apply
CO3: Apply Reliability Centered Maintenance for industrial systems	Apply
CO4: Illustrate TPM and global trends in maintenance management	Apply
CO5: Demonstrate use of simple instruments used for condition monitoring in maintenance	Apply

Text Book(s):

T1. Seiichi Nakajima, "Introduction to TPM", Productivity Press, Chennai, 2010.

T2. Gopalakrishnan, P. and Banerji, A.K., "Maintenance and Spare Parts Management", Prentice – Hall of India Pvt. Ltd., 2013.

Reference(s):

R1. Goto, F., "Equipment planning for TPM Maintenance Prevention Design", Productivity Press, 1992.

R2. David J. Sumanth, "Total Productivity Management : A Systematic and Quantitative Approach to Compete in Quality, Price and Time", Productivity Press, 1997.

Web References:

1. http://www.plant-maintenance.com/articles/tpm_intro.pdf
2. http:// www.ame.org/sites/default/files/TPM-introduction-AME.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEC1016	Course Title: QUALITY ENGINEERING (Common to AU, MC & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Metrology and Measurements.

Course Objectives

The course is intended to:

1. Explain the need of quality and customer satisfaction.
2. Explain the basics of Quality cost with classification.
3. Explain the concept of total quality management relevant to both manufacturing and service industry.
4. Explain the various tools used in Quality Engineering and Management.
5. Explain the steps used for Designing for Quality.

UNIT I INTRODUCTION 9

Introduction – Need for quality – Evolution of quality – Different Definitions and Dimensions of Quality– Concepts of Product and Service Quality– Contributions of Deming, Juran and Crosby – Barriers to Quality – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, and Customer retention – Costs of Poor quality.

UNIT II QUALITY COSTS 9

Basic Concept Quality Costs: Fitness for Use, Quality Characteristics, Parameters of Fitness for use-Quality functions, Concept of Quality assurance and Quality control, Quality costs concept, Quality cost categories, Examples of Quality cost studies, Securing the Cost figures, Pareto Analysis, Cost reduction Programs and economics of quality.

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UNIT III TOTAL QUALITY MANAGEMENT 9

Total quality Management- Basic concepts of TQM, historical review, leadership, concepts, role of senior management, quality statements, plans for process parameters, Modern Quality Management Techniques-Benchmarking, QFD, Taguchi quality loss function TPM,Lean Manufacturing continuous improvement techniques, JIT systems, Cause and effect diagrams, Scatter diagram, Run charts, Affinity diagrams, Inter-relationship diagram, Process decision program charts, PDCA Concept

UNIT IV QUALITY ENGINEERING AND MANAGEMENT TOOLS 9

Quality Engineering and Management Tools, Techniques & Standards: 7 QC tools, 7 New Quality Management Tools, 5S Technique, Kaizen, Poka-Yoke, SMED, Quality Circle, Cost of Quality Technique, Introduction to Quality Management Standards – ISO 9000, IATF 16949, ISO 14001, ISO 45001, ISO 50001 (Concept, Scope, Implementation Requirements & Barriers, and Benefits), Introduction to National and International Quality Awards.

UNIT V DESIGNING FOR QUALITY 9

Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA) – Concept, Methodology and Application (with case studies). Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitations – DOE

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the need of quality and customer satisfaction.	Understand
CO2: Explain the basics of Quality cost with classification	Understand
CO3: Explain the concept of total quality management relevant to both manufacturing and service industry.	Understand
CO4: Explain the various tools used in Quality Engineering and Management.	Understand
CO5: Explain the steps used for Designing for Quality	Understand

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Text Book(s):

T1. K C Jain and A K Chitale "Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000)", Khanna Publishers, 2008.

T2. Dale H. Besterfield , "Total Quality Management" Pearson Education, 2018.

Reference(s):

R1. Juran and Gryna "Quality planning and Analysis", TMH, New Delhi,2010.

R2. B. L. Hanson & P. M. Ghare, "Quality Control & Application", Prentice Hall of India, 2001.

Web References:

1. http://www.nptel.ac.in
2. http://www.ocw.mit.edu

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code:19MEEN1034	Course Title: LEAN SIX SIGMA		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Course Objectives:

1. Explain the processes of customer voice.
2. Explain the data collection techniques.
3. Explain the process of analysis phase in data processing.
4. Explain the various tools used in improving the data.
5. Explain the varous lean manufacturing tools.

UNIT I DEFINE PHASE 9

Overview of Six Sigma, DMAIC, Financial Benefits of Six Sigma - The impact of Six Sigma to the Organization, Defining Roles and Responsibilities -Voice of the Customer, Translating Customer Needs in to Specific Requirements - Project Definition, Project Charter, Developing a Business Case, Kano & SIPOC Diagram

UNIT II MEASURE PHASE 9

Data Collection Techniques & Plan, Data Attributes (Continuous Versus Discrete) - Measurement System Analysis, Understanding Variation, Normal Distributions - Visually Displaying Data (Histogram, Run Chart, Pareto Chart, Scatter Diagram) -Measuring Process Capability & Process Capability indices, Calculating Sigma Level .

UNIT III ANALYSIS PHASE 9

Basic Statistical Concepts, Data Segmentation and Stratification - Value-Added Analysis, Cause and Effect Analysis .(Fishbone, lshikawa) - Verification of Root Causes, Determining Opportunity for improvement - Hypothesis Testing: t-test, f-test, Regression Analysis, ANOVA.

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UNIT IV IMPROVE AND CONTROL PHASE 9

Screen potential causes, Discover Variable Relationship , Operating Tolerances, QFD.FMEA, Poka Yoke, Brain storming, Bench Marking, Multi-voting - Piloting your solutions, Implementation planning .

Define and Validate Measurement System on Actual application - Determine Process Capability. - Implement process Control, Tools: Control charts & process Management charts.

UNIT V LEAN MANUFACTURING TOOLS 9

Lean Manufacturing tools– Kanban– 5S - Kaizen -Bottleneck Analysis -Just-in-Time (JIT) - Value Stream Mapping - Overall Equipment Effectiveness (OEE) -Plan-Do-Check-Act (PDCA) -Error Proofing - Root Cause Analysis (RCA) -Poka Yoke

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Explain the processes of customer voice.	Understand
CO2:Explain the data collection techniques.	Understand
CO3:Explain the process of analysis phase in data processing.	Understand
CO4:Explain the various tools used in improving the data.	Understand
CO5:Explain the varous lean manufacturing tools.	Understand

Text book(s):

1. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw – Hill 2003
2. Thomas Pyzdek, The Six Sigma Handbook, McGraw-Hill,2000

Reference(s):

1. Fred Soleimannejed , Six Sigma, Basic Steps and Implementation, AuthorHouse, 2004
2. Forrest W. Breyfogle, III, James M. Cupello, Becki Meadows, Managing Six Sigma:A Practical Guide to Understanding, Assessing, and Implementing the Strategy That

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Yields Bottom-Line Success, John Wiley & Sons, 2000

3. James P. Womack, Daniel T.Jones, Lean Thinking, Free Press Business, 2003.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td colspan="2">Course Code: 19MEEC1002</td><td colspan="2">Course Title: DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT
(Common to AU, MC & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Machine Design

Course Objectives

The course is intended to:

1. Explain the design principles for manufacturability.
2. Describe the factors influencing form design.
3. Explain the machining consideration while design.
4. Optimize the given casting part.
5. Explain the environmental consideration in design.

UNIT I INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits -Datum features - Tolerance stacks, GD & T.

UNIT II FORM DESIGN OF CASTINGS, FORGINGS AND WELDMENTS 9

Working principle, Material, Manufacture, Design- Possible solutions – Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

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UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION 9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.

UNIT V DESIGN FOR THE ENVIRONMENT AND DFMA TOOLS 9

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the design principles for manufacturability considering strength, process capability and tolerances.	Understand
CO2: Describe the factors influencing form design of castings, forgings and welding.	Understand
CO3: Explain the machining consideration while design such as machinability, economy, clampability, accessibility and assembly.	Understand
CO4: Explain the given casting part by applying design principles.	Understand
CO5: Explain the environmental consideration in design while using DFMA tools.	Understand

Text Book(s):

T1. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight , "Product Design for Manufacture and Assembly", Third Edition, T&F INDIA, 2019

T2. Boothroyd, G, "Design for Assembly, Automation and Product Design"., Marcel Dekker, New York 2005

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Reference(s):

R1. Harry Peck , “Designing for Manufacture”, Pitman Publishing, 1973.

R2. Dickson, John. R, and Corroda Poly, “Engineering Design and Design for Manufacture and Structural Approach”, Field Stone Publisher, USA, 1999.

R3. Fixel, J. “Design for the Environment” McGraw hill., 2011.

Web References:

1. http://www.nptel.ac.in/courses/112101005/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-008-design-and-manufacturing-ii-spring-2004/lecture-notes/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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<table>
<tr><td>Course Code: 19MEEC1015</td><td colspan="3">Course Title: PRINCIPLES OF MANAGEMENT
(Common to MC & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Describe the role of managers.
2. Explain the significance of planning, decision making and strategies for international business.
3. Explain the significance of organizing the tasks.
4. Explain the motivational theories.
5. Explain the control techniques.

UNIT I OVERVIEW OF MANAGEMENT 9

Organization – Management – Role of managers – Evolution of Management thought – Organization and the environmental factors – Managing globally – Strategies for International Business.

UNIT II PLANNING 9

Nature and Purpose planning – Planning process – Types of plans – Objectives – Managing by objective (MBO) Strategies – Types of strategies – Policies – Decision Making – Types of decision –Decision Making Process - Rational Decision Making Process – Decision Making under different conditions.

UNIT III ORGANISING 9

Nature and purpose of organizing – Organization structure – Formal and informal groups / organization – Line and Staff authority – Departmentation – Span of Control – Centralization and Decentralization – Delegation of authority – Staffing – Selection and Recruitment – Orientation Career Development – Career stages – Training –

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Performance Appraisal.

UNIT IV DIRECTING 9

Creativity and Innovation – Motivation and Satisfaction – Motivation Theories Leadership – Leadership theories – Communication – Hurdles to effective communication – Organization Culture – Elements and types of culture – Managing cultural diversity

UNIT V CONTROLLING 9

Process of controlling – Types of control – Budgetary and non-budgetary control techniques – Managing Productivity – Cost Control – Purchase Control – Maintenance Control – Quality Control – Planning operations.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Describe the role of managers with reference to an organization context and business.	Understand
CO2: Explain the significance of planning, decision making and strategies for international business to accomplish the organizational goal.	Understand
CO3: Explain the significance of organizing the tasks to accomplish the organizational goal.	Understand
CO4: Explain the motivational theories to increase the productivity and retention rate of employees.	Understand
CO5: Explain the control techniques such as budgetary, maintenance, quality to accomplish the organizational goal.	Understand

Text Book(s):

T1. Stephen P. Robbins, Rolf Bergman and Mary Coulter, “Management”, Prentice Hall of India, 8th edition, 2017.

T2. Charles W.L Hill, Steven L McShane, “Principles of Management”, Mcgraw Hill Education, 2008.

Reference(s):

R1. Hellriegel, Slocum & Jackson, “Management – A Competency Based Approach”, Thomson South Western, 10th edition, 2007.

R2. Harold Koontz, Heinz Weihrich and mark V Cannice, “Management – A global &

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Entrepreneurial Perspective”, Tata McGraw Hill, 12th edition, 2007.

R3. Andrew J. Dubrin, “Essentials of Management”, Thomson Southwestern, 7th edition, 2007.

Web References:

1. http://www.managementstudyguide.com/all-subjects.htm

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	2	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	2	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	2	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	2	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	2	1	-	-

High-3; Medium-2; Low-1

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Course Code: 19MEEC1017	Course Title: INDUSTRIAL SAFETY MANAGEMENT (Common to AU, MC & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Manufacturing Technology

Course Objectives

The course is intended to:

1. Explain the importance of safety management.
2. Explain the measurement and monitoring techniques.
3. Explain the roles and responsibilities of Safety department.
4. Describe the importance of Industrial safety acts.
5. Explain the classes of fires and controlling techniques.

UNIT I INTRODUCTION TO SAFETY MANAGEMENT 9

Principles of Safety Management ,Need of safety in organisation, Occupational Health & hygiene, modern safety concept-Safe operating procedure (SOP's), Safety permits, Social and physiological effects, Behavioural based safety- aim, benefits, law and rules, Accident - Near Miss, injury, Cost of accident, Unsafe act , Unsafe condition, Environmental safety - air pollution, water pollution ,industrial noise & vibration control ,physical hazards - chemical hazards , biological hazards, electrical hazards.

UNIT II SAFETY PERFORMANCE MONITORING 9

Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, Components of safety audit, types of audit, audit methodology, permanent total disabilities, permanent partial disabilities, temporary total disabilities - Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention incident rate, accident rate, safety “t” score, safety activity rate Records of accidents, accident reports.

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UNIT III SAFETY ORGANISATION 9

Role and responsibilities of management and line staffs Supervisors and Employees, Safety committee, Motivation, budgeting for safety, safety policy, Safety Education and Training, Importance of training-identification of training needs- Training methods – programme, seminars, conferences, role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training, Personal Protective Equipment (PPE) - Requirements of PPE, Selection and Usage of PPE, Importance of IS Standard, Types of PPE

UNIT IV INDUSTRIAL ACTS 9

Indian Factories act 1948, Tamilnadu Factories rule 1950 – Environmental protection act 1986- Indian electricity act 1910, Indian electricity rule 1956 – Indian boiler act 1923 – Workmen's compensation act 1923 – Explosive act1983 - Noise pollution rules 2000

UNIT V DISASTER MANAGEMENT AND EMERGENCY PREPAREDNESS 9

Fire properties of solid, liquid and gases - fire spread - toxicity of products of Combustion - sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – a, b, c, d, e – fire extinguishing agents - fire stoppers, Emergency preparedness and responsibilities, On site and off site emergency plan, Mock drill Bhopal Gas tragedy - faulty handling of equipment's, failure of hoist, crane.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the importance of safety management to control the accidents, pollution and hazards.	Understand
CO2: Explain the measurement and monitoring techniques to report the safety performance.	Understand
CO3: Explain the roles and responsibilities of Safety department in an organization to eliminate the unsafe act and conditions.	Understand
CO4: Describe the importance of Industrial safety acts related to safety environment pollution in India.	Understand
CO5: Explain the classes of fires and controlling techniques and plan for an onsite and offsite emergency.	Understand

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Text Book(s):

T1. Deshmukh .L.M "Industrial Safety Management" McGraw-Hill, 2006.

T2. C.RayAsfahl "Industrial Safety and Health management" Pearson Prentice Hall, 2010.

Reference(s):

R1. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.

R2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980

R3. Subramanian.V., "The Factories Act 1948 with Tamilnadu factories rules 1950", Madras Book Agency, 21st ed., Chennai, 2000.

Web References:

1. http://www.icebookshop.com
2. http://nptel.ac.in/courses/112107143/40

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	1	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEEN1003	Course Title: MOTOR CYCLE DYNAMICS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the courses:

- Theory of Machines

Course Objectives

The course is intended to:

1. Determine the magnitude of design parameters in a braking system of motorcycle.
2. Determine the magnitude of design parameters in a suspension system.
3. Determine the magnitude of design parameters for stability and maneuverability.
4. Choose a suitable tyre for a given condition based on the characteristics of tyres.
5. Explain the impact of aerodynamic parameters on the vehicle performance.

UNIT I BASICS OF MOTORCYCLE DYNAMICS AND BRAKES 9

Introduction to Motorcycle dynamics – Basics of motorcycle dynamics – Coordinate system and important definitions Frictional force, deceleration & Simple brake calculations – Dynamics during braking – Introduction to CBS, ABS.

UNIT II DYNAMICS OF SUSPENSION 9

Sprung mass, Un-sprung mass and vibration modes Quarter car and half car models – Suspension elements and design parameters.

UNIT III STABILITY AND MANEUVERABILITY 9

Introduction – Definitions – Vibration modes – Study of dynamics in steady turn – SHM, Transient maneuvers, input & output parameters – Design parameters for stability and maneuverability, geometrical, mass and structural stiffness**.**

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UNIT IV TYRE DYNAMICS **9**

Introduction to tyre – Types of tyres – Tyre characteristic curve, vertical, cornering, camber stiffness, rolling resistance, magic formula.

UNIT V ERGONOMICS AND AERODYNAMICS **9**

Introduction and importance – Elements of ergonomics – Riding posture design, 'H' point, seat design. Aerodynamics - Introduction – Definitions – Aerodynamics parameters – Effect on vehicle performance

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Determine the magnitude of design parameters in a braking system of motorcycle such as friction force and stopping distance.	Apply
CO2: Determine the magnitude of design parameters in a suspension system such as type of springs, spring stiffness and pitch.	Apply
CO3: Determine the magnitude of design parameters for stability and maneuverability such as geometrical, mass and structural stiffness.	Apply
CO4: Choose a suitable tyre for a given condition based on the characteristics of tyres such as vertical, cornering, camber stiffness, rolling resistance.	Apply
CO5: Determine the impact of aerodynamic parameters on the motorcycle performance.	Apply

Text Book(s):

T1. Tony Foale, "Motorcycle Handling and chassis design" Tony Foale designs, 2006.

T2. V Cossalter, "Motorcycle Dynamics", Published by Race dynamics, 8421 Midland Dr., Greendale, 2002.

Reference Book(s):

R1. Tom Birch, Thomas Wesley Birch, "Automotive Chassis Systems", Delmar, Thomson Learning, 1999.

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

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Course Code:19MEEN1035	Course Title: ELECTRIC VEHICLE DESIGN		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives:

The course is intended to

1. Acquire knowledge on heat transfer.
2. Prepare drive design.
3. Design electric motor and drive train.
4. Explain about energy storage.
5. Design auxiliary system.

UNIT I BEVS DYNAMICS, POWERTRAIN COMPONENT MODELING, AND HEAT TRANSFER MODELLING 9

Battery electric vehicle (BEV) power train - Vehicle dynamics - Transmission - auxiliary loads - Electric Vehicle Chassis and Body Design - Body/Chassis Requirements - Layout - Strength, Rigidity and Crash Resistance - Designing for Stability - Suspension for Electric Vehicles - Chassis used in Modern Battery and Hybrid Electric Vehicles

UNIT II DRIVE DESIGN FOR EVS 9

Different drives - induction machines - BLDC –SRM motors - constant power - constant torque regions - Number of phases - Frequency - Rated output in kW - Type of duty - Voltage connections - Temperature rise - Speed- Pullout torque - Starting torque - Starting current - Power factor - Efficiency/losses.

UNIT III ELECTRIC MOTOR AND DRIVE TRAIN CONTROLLER DESIGN 9

Brushless motor design considerations – innovative drive scheme - motor cooling - efficiency - size and mass - improving motor efficiency

UNIT IV ENERGY STORAGE MODELLING 9

Purpose of Battery Modelling - Equivalent Circuit - Modelling Battery Capacity - Simulating a Battery at a Set Power - Calculating the Peukert Coefficient - Approximate Battery Sizing – Battery Swapping

UNIT V DESIGN OF AUXILIARY SYSTEMS 9

Heating and Cooling Systems - Design of the Controls - Power Steering - Choice of Tyres - Wing Mirrors, Aerials and Luggage Racks.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the knowledge on heat transfer.	Understand
CO2: Prepare drive design.	Apply
CO3: Design electric motor and drive train.	Apply
CO4: Explain about energy storage.	Understand
CO5: Design auxiliary system.	Apply

Text Book(s):

1. Larmine J and Lowry J , "Electric Vehicle Technology Explained", First, John Wiley & Sons, Vancouver, 2012.
2. Hayes.G and Goodarzi , "Electric Powertrain- Energy systems, power electronics and drives", First, Jhon Wiley, Sussex, 2018.

Reference(s):

1. Mi Chris and Masur Abul , "Hybrid electric vehicles", 3rd Edition, John Wiley, 2018.
2. Liu Wei , "Introduction to Hybrid vehicle systems Modeling and Control", 1st Edition, John Wiley, 2017.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19EEEC1049		Course Title: ADVANCED SENSORS FOR ELECTRIC VEHICLE (Common to EEE & ME)	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Electronic devices
- Engineering physics

Course Objectives

The course is intended to:

1. Inculcate knowledge of digital transducers
2. Understand the seven generations of IoT sensors to appear.
3. Introduce the sensor technology for advanced driver assistance systems.
4. Disseminate the knowledge of sensor networks.
5. Provide the basic concepts of intelligent sensor systems.

Unit I Digital Transducers **9**

Digital voltmeter -Ramp type, Integrating type, ADC, Digital frequency meter - Working principle and applications. Frequency meter, Electronic counters - Transducers for the measurement of DC and AC voltages and currents - CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors.

Unit II Seven Generations of IoT Sensors **9**

Industrial sensors –Description and Characteristics–First Generation –Description and Characteristics–Advanced Generation –Description and Characteristics–Integrated IoT Sensors –Description and Characteristics–Polytronics Systems –Description and Characteristics–Sensors' Swarm –Description and Characteristics–Printed Electronics –Description and Characteristics–IoT Generation Roadmap

Unit III Sensor Technology for Advanced Driver Assistance Systems **9**

Basics of Radar Technology and Systems - Ultrasonic Sonar Systems - Lidar Sensor Technology and Systems - Camera Technology - Night Vision Technology - Use of Sensor

Data Fusion - Integration of Sensor Data to On-Board Control Systems

Unit IV Sensor Networks 9

Introduction to sensor network, Unique constraints and challenges, Localization and Tracking, Networking Sensors, Infrastructure establishment, Sensor Tasking and Control, Sensor network databases, Sensor Network Platforms and tools, Industrial Applications and Research directions.

Unit V Intelligent Sensor Systems 9

Intelligent Sensor Systems- Intelligent pressure, Flow, Level, Temperature Sensors - Intelligent sensor, Complex sensors, biometric sensors - Application of intelligent sensor in electric vehicles.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Explain the concept digital transducers	Understand
CO2.	Describe the seven generations of iot sensors to appear.	Understand
CO3.	Make use of the sensor technology for advanced driver assistance systems.	Apply
CO4.	Outline the sensor networks.	Understand
CO5.	Make use of the different intelligent sensor systems.	Apply

Text Book(s):

T1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.

T2. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018

Reference Book(s):

R1. Robert Bosch Gmbh, Automotive Electrics and Automotive Electronics, Systems and Components, Networking and Hybrid drive, 5th Edition, Springer Vieweg, Wiesbaden 1998.

R2. Mehrdad Ehsani Yimin Gao Stefano Longo Kambiz M. Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Taylor & Francis Group, LLC, 2018.

R3. Denton.T , Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair, 2012

Web References:

1. http://nptel.ac.in/courses/117106093/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEC1050	Course Title: TESTING AND CERTIFICATION OF ELECTRIC VEHICLE (Common to EEE & ME)		
Course Category: ProfessionalElective		Course Level: Mastery	
L: T:P (Hours/Week): 3:0:0	Credit :3	Total Contact Hours: 45	Total Marks: 100

Pre-requisites:

- Basics of Electrical, Automobile and Mechanical engineering

Course objectives:

The course is intended to

1. Define the parameters, instruments and types of testing of vehicles
2. Explain the static testing of vehicles
3. Describe the dynamic testing of vehicles
4. Enumerate various component Testing in vehicles
5. Indicate tests for retro-fitment and charging station

Unit I Introduction 9

Specification and Classification of Vehicles (M, N and O layout), Homologation and its Types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks, Hardware in The Loop concepts for EV/HEVs.

Unit II Static Testing of Vehicle 9

Photographs, CMVR physical verification, Tyre Tread Depth Test, Vehicle Weightment, Horn installation, Rear view mirror installation, Tell Tales, External Projection, Wheel Guard, Arrangement of Foot Controls for M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement of Temporary Cabin For Drive– Away — Chassis, Electric vehicle – Safety Norms, Energy consumption and Power test

Unit III Dynamic Testing of Vehicle 9

Hood Latch, Gradeability, Pass-by Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed Fuel Consumption, Cooling Performance, Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broad band / Narrow band EMI Test, Electric vehicle — Range Test.

Unit IV Vehicle Component Testing 9

Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test, Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test, Tyre& Wheel Rim Test, Bumper Impact Test, Side Door Intrusion, Crash test with dummies, Demist test, Defrost Test, Interior Fittings, Steering Impact test (GVW<1500 kg), Body block test, Head form test, Driver Field Of Vision, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints test, Airbag Test, Accelerator Control System, Motor power, Safety Requirements of Traction Batteries, EMI-EMC (CI, BCI, RE,RI and CTE).

Unit V Tests for Hybrid Electric Vehicles, Retrofitment and Charging Station 9

Hybrid Electric Vehicles Tests (M and N category), Tests for Hybrid Electric System Intended for Retrofitment on Vehicles of M and N Category (GVW < 3500 kg), Test for Electric Propulsion kit intended for Conversion, Test for Electric Vehicle Conductive AC Charging System, and Test for Electric vehicle conductive DC charging system.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1	Define the parameters, instruments and types of testing of vehicles	Apply
CO2	Explain the static testing of vehicles	Apply
CO3	Describe the dynamic testing of vehicles	Apply
CO4	Enumerate various component Testing in vehicles	Apply
CO5	Identify tests for retro-fitment and charging station	Apply

Text Books

T1. Vehicle Inspection Handbook", JJ Keller and Associates ,Inc,2020

T2. Michael Plint& Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd Edition, 2007

Reference Book(s):

R1. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010

R2. Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007

R3. Arvey Segler, " Body Language: Discovering & Understanding the Psychologicalsecrets behind reading & Benefiting from Body Language” Kindle Edition, 2016

R4. M. Ehsani, Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and FuelCell Vehicles, CRC Press, 2005.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	-	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	-	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	-	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	3	-	-

High-3; Medium-2; Low-1

Course Code: 19AUEC1006	Course Title: ELECTRIC VEHICLE ARCHITECTURE		
Course Category: ProfessionalElective		Course Level: Mastery	
L: T:P (Hours/Week): 3:0:0	Credit :3	Total Contact Hours: 45	Total Marks: 100

COURSE OBJECTIVES:

1. Understand the structure of Electric Vehicle
2. Explain the vehicle mechanics
3. Describe about the EV conversion components
4. Understand about the details and specifications for Electric Vehicles
5. Apply the concepts of Plug-in Hybrid Electric Vehicle

UNIT I VEHICLE ARCHITECTURE AND SIZING 9

Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

UNIT II VEHICLE MECHANICS 9

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT III POWER COMPONENTS AND BRAKES 9

Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.

UNIT IV HYBRID VEHICLE CONTROL STRATEGY 9

Vehicle supervisory controll, Mode selection strategy, Modal Control strategies.

UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE 9

Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Summarize the History and Evolution of EV	Understand
CO2: Describe the basics of Vehicle mechanics	Understand
CO3: Explain the different power components and brakes for EVs	Understand
CO4: Describe the control strategy in the Plug-In Hybrid Electric Vehicles	Apply
CO5: Design Hybrid Electric Vehicle for different applications	Understand

Text Book(s):

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.

2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.

3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.

4. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.

5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021

Reference(s):

1. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020

2. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, Thermo, 2021, 1, 134–150. https://doi.org/10.3390/thermo1020010.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

Course Code:19MEEN1037	Course Title: ELECTRIC VEHICLE THERMAL ENGINEERING		
Course Category: Professional Electives		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Pre-requisites: NA

Course Objectives:

The course is intended to

1. Explain about thermal management system.
2. Acquire knowledge on HV battery.
3. Describe the features of 3D Thermal simulation.
4. Design thermal cooling system.
5. Acquire knowledge on controller design.

Unit I Introduction

Introduction on Electric Power train Systems - Introduction to thermal management systems in EV - Source of heat generation in electric power train- Types of cooling architecture in EVs- Introduction to Thermodynamics and Heat transfer- Modes to heat transfer

Unit II Thermal Management of electric Motor and HV Battery

Motor types and applications- Motor performance characteristics- Electric Motor thermal system – Modeling and simulation- HV battery classifications- Factors effecting battery performance- Types of battery cooling methods- Control system design for Battery management system-Motor specifications for EVs

Unit III Thermal Management of Power electronics and 3D Thermal simulation

Introduction- Power Loss Modeling- Parameter Identification- Sensitivity Analysis- Heat transfer Mechanism- Thermal influence & component protection, evaluation on Battery management system- Heat network across vehicle sub system[motor]- Concept design & different type of cooling channel design.

Unit IV HVAC Cooling

Introduction- Components of HVAC system- Power consumption from HVAC system-Impact of HVAC operation on EV performance- Modeling& Simulation of HVAC system.

Unit V Controller design for Thermal system

State space control & Design of Observer- Introduction to Vehicle Control unit & Thermal controls-Performance Optimization by Thermal control- Parameter Identification- Sensitivity analysis.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1	Explain about thermal management system.	Understand
CO2	Acquire knowledge on HV battery.	Understand
CO3	Describe the features of 3D Thermal simulation.	Understand
CO4	Design thermal cooling system.	Apply
CO5	Acquire knowledge on controller design.	Understand

Text Book:

1. Ibrahim Dincerm, Halilm S Hamut and Nader Javani“Thermal Management of Electric Vehicle Battery Systems ” John Wiley2017
2. Bruno Sacrasati and Werner Tillmatz “Advances in Battery Technology for Electric Vehicles ” Elsevier Woodhead Publishing Series in Energy 2015

References:

1. Ali Emadi, “Advanced Electric Drive Vehicles” CRC Press, 2014.
2. Micah Toll, "The Ultimate Do It Yourself Ebike Guide: Learn How To Build Your Own Electric Bicycle" ISBN 978-09899067- 9 1, 2013.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

Course Code: 19MEEN1016	Course Title: BATTERY SYSTEM FOR ELECTRIC VEHICLES		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Pre-requisites:

- Computer Aided Machine Drawing Laboratory

Course Objectives:

The course is intended to:

1. Select suitable Li-Ion battery cells.
2. Prepare mechanical assembly drawings of battery systems.
3. Design battery management systems.
4. Prepare vehicle layout for sub-systems .
5. Perform cost benefit analysis of battery sub systems.

UNIT I LI-ION BATTERY 7

Significance of Li-ion batteries - Classification of Li-Ion batteries - Construction of Li-Ion batteries - Energy density - Charging and discharging profiles - influence of temperature - life and ageing issues - Safety aspects and thermal runaway.

UNIT II LI-ION BATTERY SYSTEMS 8

Battery systems and subsystems - Battery modules - Cells in series and parallel configurations - Battery cooling systems - Battery management systems - Cell balancing - Battery housing - Assembly of battery systems - Production aspects - Regulations on battery systems.

UNIT III BATTERY MANAGEMENT SYSTEM 10

Battery management systems: functions and architecture, performance parameter measurement, equalization management circuit, data communication, logic and safety control, testing stability.

UNIT IV INTEGRATION ASPECTS IN AN ELECTRIC VEHICLE (2 & 4 WHEELER) 10

Expectations from an electric vehicle - Vehicle design, body styles - Vehicle layout - Vehicle’s subsystems - Vehicle concepts - Longitudinal dynamics of an electric vehicle, torque demand - Crash requirements and vehicle's safety requirements.

UNIT V TRENDS AND OUTLOOK 10

Study of battery systems in electric passenger vehicles (Bus, Car and Two Wheeler) - Production and cost analysis - Mass production demands - Cell manufacturing - Demands on cooling systems - Fast charging and charging stations - Second life use for battery packs - Solid state batteries - Ecosystem for electric vehicles.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Select suitable Li-Ion battery cells for use in electric vehicles based on the calculation of various cell parameters	Apply
CO2: Prepare mechanical assembly drawings of battery systems for electric vehicles using available CAD software	Apply
CO3: Design battery management system for various battery systems to obtain peak performance by monitoring and charge equalization.	Apply
CO4: Prepare vehicle layout for sub-systems in TWO and FOUR wheelers using available CAD software	Apply
CO5: Perform cost benefit analysis of battery sub systems based on market conditions and manufacturability	Apply

Text Book(s):

T1. Reiner Korthauer, “Lithium-Ion Batteries: Basics and Applications” , Springer, August 2018. ISBN 978-3-662-53069-6

Reference(s):

R1. Jiuchun Jiang and Caiping Zhang, “Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles”, Wiley, 2015.

ISBN 978-1-118-41478-1

R2. Seth Leitman and Bob Brant, “Build Your Own Electric Vehicle” , McGraw Hill, 2013. ISBN 978-0-07-177056-9

R3. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2018. ISBN 978-81-265-5670-8

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code: 19AUEC1005</td><td colspan="3">Course Title: ELECTRIC VEHICLE POWERTRAINS
(Common to AU & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3 : 1 : 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max. Marks: 100</td></tr>
</table>

Pre-requisites:

- Nil

Course objective:

Course is intended to:

1. Calculate battery and pack parameters for electric vehicles
2. Select traction machines for electric vehicles
3. Select converters and controllers for electric vehicles
4. Select sensors for electric vehicles
5. Perform cost benefit analysis of electric vehicles

UNIT I ELECTRIC VEHICLE AND BATTERY PACKS 9

Longitudinal vehicle dynamics: vehicle load forces, vehicle acceleration, drive cycle. Electric vehicle architecture: subsystems, BEV, PHEV, HEV, FCEV.

Energy source: introduction to batteries, lifetime and sizing considerations, battery charging, management and protection systems, battery chemistries and models. Battery pack design: parameters, configuration, capacity, range, C-rates, SoC, SoH, SoF.

UNIT II TRACTION MACHINES 9

Introduction to traction machines: propulsion machine, machine specifications, characteristic curves, conversion factors for machine units. Machine structure, operation, specifications, characteristic curves, using machine for EV powertrain, thermal characteristics of Brushed DC machine, Brushless DC machine, Induction machine, PMSM machine.

UNIT III CONVERTERS AND CONTROLLERS 9

DC DC converters: power conversion basic principles, buck converter, boost converter, power semiconductors, passive components, interleaving. Inverters: three phase inverters, modulation schemes, sinusoidal modulation, inverter power losses.

Controller: introduction to control of traction machines, control of DC machines, control of induction machines, control of PMSM, BLDC, DC machines.

UNIT IV BMS, SENSORS AND COMMUNICATION 9

BMS: significance, cell balancing, architecture, types. Sensors: current, voltage, temperature, pressure and position. SoC, SoH and SoF measurement. ASICs. Communication: protocols, CAN, CANOpen, FlexRay.

UNIT V COST ANALYSIS 9

Market trends: batteries, traction motors, converters, controllers, BMS, sensors and communication. Technology updates in electric vehicles. System component layout: design of mechanical structures, optimization of space and layout. Renewable energy: charging infrastructure, types, GHG reduction potential.

Course Outcomes: **At the end of the course students will be able to:**	**Cognitive Level**
CO1. Calculate parameters associated with electric vehicle batteries and packs for various two, three, four wheeler, and special applications.	Apply
CO2. Select traction machines based on the requirements using machine characteristic curves, specifications and performance.	Evaluate
CO3. Select converters and controllers based on the technical specifications and electric vehicle system requirements.	Evaluate
CO4. Select sensors for measurement as part of management of the vehicle performance.	Evaluate
CO5. Perform cost benefit analysis of electric vehicle powertrains based on market trends, technology, environment, and sustainability.	Apply

Text Book(s):

T1. John G. Hayes and G. Abas Goodarzi, “ Electric Powertrain”, First Edition, John Wiley and Sons, 2018. ISBN:9781119063667

T2. Luis Romeral Martinez and Miguel Delgado Prieto, “ New Trends in Electrical Vehicle Powertrains, Intechopen, 2019. ISBN:9781838816988.

T3. Sam Davis, “Managing Electric Vehicle Power”, SAE International, 2020. ISBN:9781468601442

Reference Book(s):

R1. Xudong Zhang, “Modeling and Dynamics Control for Distributed Drive Electric Vehicles”, Springer, 2021.

R2. Sang-Hoon Kim, “Electric Motor Control: DC, AC, and BLDC Motors”, Elsevier, 2017..

Web References:

1. https://nptel.ac.in/courses/108/106/108106182/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	2	-	1	-	-
CO2	3	3	2	2	-	-	-	1	-	2	-	1	-	-
CO3	3	3	2	2	-	-	-	1	-	2	-	1	-	-
CO4	3	3	2	2	-	-	-	1	-	2	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	2	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19AUEC1007	Course Title: ELECTRIC VEHICLE CHARGING SYSTEM		
Course Category: Professional Elective		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Prerequisites

The student should have undergone the courses:

- Automotive Electrical and Electronics

Course Objective

The course is intended to

1. Explain the charging station and standards
2. Describe the concepts of power converters in charging
3. Understand the charging scheme in renewable based EV charging
4. Demonstrate the wireless power transfer technique
5. Design of power factor correction circuits

UNIT I CHARGING STATIONS AND STANDARDS 9

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Static and dynamic charging, Bidirectional power flow, International standards and regulations.

UNIT II POWER ELECTRONICS FOR EV CHARGING 9

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 9

Introduction - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVC-HSP system - fast-charging infrastructure with solar PV and energy storage. Protocols for EV charging system.

UNIT IV WIRELESS POWER TRANSFER 9

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

UNIT V POWER FACTOR CORRECTION IN CHARGING SYSTEM 9

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Illustrate various charging techniques and to know charging standards and regulations.	Understand
CO2. Demonstrate the working of DC-DC converters used for charging systems and principles	Understand
CO3. Illustrate the advantages of renewable system based charging systems	Understand
CO4. Demonstrate the principles of wireless power transfer	Understand
CO5. Design the required parameters for power factor correction	Apply

Text Book(s):

T1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.

T2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.

T3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.

Reference Book(s):

R1. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, SanjeevikumarPadmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.

R2. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.

R3. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

Course Code: 19MEEC1019	Course Title: INDUSTRIAL IOT (Common to AU, MC & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Explain the basic concepts of IIoT.
2. Explain the various Architectures of IIoT.
3. Explain the sensors available in IIoT based on application requirement.
4. Explain the basics of Big Data and IoT Analytics.
5. Explain the various applications of IoT .

UNIT I INTRODUCTION 9

Introduction to IoT, IoT Vs. IIoT, History of IIoT, Components of IIoT -Sensors, Interface, Networks, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Role of IIoT in Manufacturing Processes, Sustainability through Business excellence tools Challenges & Benefits in implementing IIoT.

UNIT II ARCHITECTURES 9

Overview of IOT components, various architectures of IOT and IIOT, Advantages & Disadvantages, IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT, IIoT Business Model and Reference Architectures, Industrial IoT-Sensing,IIoT-Processing and Communication, IIoT Networking.

UNIT III SENSOR AND INTERFACING 9

Introduction to sensors, Transducers, Classification, Roles of sensors in IIOT, Various types of sensors, special requirements for IIOT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet and BACNet.

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UNIT IV BIG DATA AND IOT ANALYTICS 9

Big Data, Characteristics of Big Data, Types of Big Data, Analysing of Data, Applications, Big Data tools, Introduction to Machine Learning and Data Science ,R and Julia Programming, IOT Analytics, Role of Analytics in IOT, Data visualization Techniques.

UNIT V IoT APPLICATIONS 9

Internet of Things Applications : City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIoT in Manufacturing Sector, Industrial IoT-Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Explain the basic concepts of IIoT.	Understand
CO2: Explain the various Architectures of IIoT.	Understand
CO3: Explain the sensors available in IIoT based on application requirement.	Understand
CO4: Explain the basics of Big Data and IoT Analytics.	Understand
CO5: Explain the various applications of IoT.	Understand

Text Book(s):

T1. Sudip Misra, Chandana Roy, Anandarup Mukherjee " Introduction to Industrial Internet of Things and Industry 4.0" CRC Press,1st edition 2020.

T2. Adrian McEwen, Hakim Cassimally "Designing the Internet of Things", John Wiley & Sons, 1st edition, 2013.

T3. Perry Lea, "Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", Packt Publishing Ltd., 2018.

T4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", Orient Blackswan Private Limited - New Delhi, 1st edition 2015.

Reference(s):

R1. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", John Wiley & Sons,2018.

R2. Joe Biron and Jonathan Follett "Foundational Elements of an IoT Solution: The Edge, The Cloud, and Application Development", Cisco Press, First Edition, 2017.

R3. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress; 1st edition 2017.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code: 19EEEC1053</td><td colspan="3">Course Title: INDUSTRY 4.0 – SMART FACTORIES</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Industrial IoT

Course Objectives

The course is intended to:

1. Understand manufacturing systems in terms of material flow and storage
2. Illustrate the structure of specific factory model.
3. Provide knowledge on manufacturing and assembly line
4. Understand the planning and simulation of smart factory
5. Explain the sustainable and digital business model.

Unit I Factory Models 9

Introduction to Factory models, single workstation factory models, processing time variability, Single-Part-Type Systems, Multi-stage single product and multi-product systems.

Unit II Special Factory Models 9

Models of various forms of batching, WIP limiting control strategies, serial limited buffer models.

Unit III Manufacturing and Assembly Lines 9

Manual Assembly lines, Automated Production lines, Automated Assembly systems, Group technology and cellular manufacturing, Flexible manufacturing cells and systems, Toyota Production System.

Unit IV Smart Factory Planning 9

Material Requirements Planning, Multi-Stage Control and Reactive Scheduling, Simulation Techniques.

Unit V Sustainable and Digital Business Models 9

Sustainability and Supply Chain– Industry 4.0 and Its Applications- Reflection of Sustainability on Business Models- Integration of I 4.0 with Sustainability- Scenarios Countering Strategies for Obsolescence.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Identify the manufacturing systems in terms of material flow and storage	Apply
CO2.	Illustrate the structure of specific factory model.	Understand
CO3.	Make use of manufacturing and assembly line	Apply
CO4.	Understand the planning and simulation of smart factory	Understand
CO5.	Explain the sustainable and digital business model	Understand

Text Book(s):

T1. M. P. Groover, Automation, “Production Systems and Computer-Integrated Manufacturing”, 4th Edition, Pearson Education, 2016.

T2. Kaushik Kumar, Divya Zindani, J. Paulo Davim,”Industry 4.0 Developments towards the Fourth Industrial Revolution”, 1st Edition, Springer, 2019

Reference Book(s):

R1. Lucas Darnell , “The Internet of Things (A Look at Real World Use Cases and Concerns)”, Kindle Edition, 2016,

R2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.

R3. Vijay Madisetti and ArshdeepBahga ,”Internet of Things (A Hands-on-Approach)”,1st Edition, VPT, 2014.

Web References:

1. https://nptel.ac.in/courses/117/105/117105079/
2. https://nptel.ac.in/courses/117/105/117105135/
3. https://nptel.ac.in/courses/117/104/117104020/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

Course Code: 19MEEN1020	Course Title: FLUID POWER SYSTEMS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the courses:

- Fluid Mechanics and Hydraulic Machinery

Course Objectives

The course is intended to:

1. Explain the fluid power systems.
2. Explain construction and working of hydraulic components.
3. Develop a hydraulic circuit.
4. Explain construction and working of pneumatic components.
5. Develop a pneumatic circuit.

UNIT I FLUID POWER SYSTEM AND FUNDAMENTALS 9

Introduction to Fluid power - Types of fluid power systems - Hydraulic system components - Pneumatic system components - Application of Pascal's Law in hydraulics-Advantages of fluid power system -Applications of Fluid power system -Properties of hydraulic fluids - Types of fluids.

UNIT II HYDRAULIC SYSTEM AND COMPONENTS 9

Pumping theory - Pump classification - Construction and working of gear pumps, Vane pumps, Piston pumps - Construction and working of linear actuators - Special cylinder - Rotary actuator – Construction and operation of direction control valves (DCV), Pressure control valve, Flow control valve – Construction and operation of accumulators, Intensifiers..

UNIT III HYDRAULIC CIRCUITS 9

Hydraulic symbols - Hydraulic circuits for linear actuators - Hydraulic circuits using different actuating devices - Speed control circuits - Sequencing circuit - Synchronizing circuit - Regenerative circuit - Accumulator circuit – Application of intensifier - Hydraulic circuit for Milling operation, Grinding Machine - Hydraulic braking in Automobile.

UNIT IV PNEUMATIC SYSTEM AND COMPONENTS 9

Properties of air – Compressor - Types of compressor - Construction and operation of air filter, air regulator, air lubricator - Pneumatic linear actuator - Rotary actuator - Constriction and working of pneumatic direction control valve – Flow control valve - Pneumatic symbols.

UNIT V PNEUMATIC CIRCUITS 9

Pneumatic circuits for single acting cylinder, Double acting cylinder - Pneumatic circuits using manual, mechanical, electrical actuating devices - Cascade method for sequencing: two and three Cylinders - Step counter method- Hydro-Pneumatic circuit - Material handling system circuit - Multiple operation Machining.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Explain the construction and working of hydraulic system components.	Understand
CO2: Develop a hydraulic circuit for milling, grinding and automobile braking application.	Apply
CO3: Explain the construction and working of pneumatic system components.	Understand
CO4: Develop a pneumatic circuit for material handling and machining application.	Apply
CO5: Explain the construction and working of hydraulic system components.	Understand

Text Book(s):

T1. Esposito Anthony, "Fluid Power with Applications", Pearson Education Inc., New York, 2015.

T2. Majumdar, S.R., "Oil Hydraulic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2010.

Reference Book(s):

R1. Srinivasan.R, "Hydraulic and Pneumatic controls", Vijay Nicole, 2011.

R2. Andrew Parr, "Hydraulics and Pneumatics, A technician's and engineer's guide", Third Edition, Butterworth-Heinemann, 2011.

R3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2012.

Web References:

1. http://www.nptel.ac.in/courses/112106175/
2. http://www.nptel.ac.in/courses/112105046/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code:19MEEN1017	**Course Title: EMBEDDED SYSTEM FOR AUTOMOBILES**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Pre-requisites:

- Nil

Course Objectives

The course is intended to:

1. Develop Knowledge on program using microcontroller.
2. Develop Knowledge to Interface peripherals with microcontroller.
3. Develop Knowledge to Interface Automotive sensors and actuator using microcontroller.
4. To aware on Advance concept in power train management system.
5. To aware on Advance concept in chassis electronics systems.

UNIT I INTRODUCTION 9

Architecture of Microcontroller- Memory organization in microcontroller, Arithmetical and logical instruction - simple programs using microcontroller- programs using branching instructions- addressing modes, branching instruction

UNIT II PERIPHERAL INTERFACING 9

Analog to Digital converter (ADC) - Interface ADC - Digital to Analog converter (DAC)- Interface DAC- stepper motor- Interface stepper

UNIT III ARDUINO 9

Digital Input and output port interfacing- Analog Input and Output interfacing- Sensor interfacing- Delay generation- Pulse generation- Motor- Head light interfacing- Interrupts – Serial communication.

UNIT IV ENGINE AND TRANSMISSION MANAGEMENT SYSTEM 9

SI Engine management system, CI Engine management system including emission control, Transmission management system.

UNIT V CHASSIS ELECTRONICS 9

Vehicle pitch, roll, yaw - Vehicle Gyro sensor and interfacing- Tyre Slip- ABS- TCS- ESP- EBD. Body electronics system wiper.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Execute simple program using microcontroller for controlling simple applications	Apply
CO2: Interface the required peripherals with microcontroller for given application	Apply
CO3: write program to Interface sensors and actuator using microcontroller	Apply
CO4: Explain the working principle of power train management system of an automobile	Understand
CO5: Explain the working principle of chassis electronics systems of an automobile	Understand

Text book(s):

T1. Frank Vahid and Tony Givargis, "Embedded system design A unified Hardware/software Introduction", Wiley India pvt. Ltd., 2012

T2. Muhammad Ali Mazidi, Janice GillispieMazidi and RolinD.Mckinlay, " The 8051 Microcontroller and Embedded system using Assembly and C" 2nd Edition, Pearson education, 2009.

References book(s):

R1. David E.Simon, “An Embedded software premier”, Pearson education, 2010.

R2. Automotive Handbook” 7th edition, Bosch, 2011.

R3. Halfacree, Gareth, and Upton, Eben. Raspberry Pi User Guide. Germany, Wiley, 2012.

R4. Hughes, J. M.. Arduino: A Technical Reference: A Handbook for Technicians, Engineers, and Makers. United States, O'Reilly Media, 2016.

Website references:

1. https://nptel.ac.in/courses/108/102/108102045/
2. https://www.arduino.cc/en/Tutorial/HomePage

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEEC1010	Course Title: FLEXIBLE MANUFACTURING SYSTEMS (Common to MC & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course:

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.

Course Objectives

The course is intended to:

1. Classify and distinguish FMS and other manufacturing systems.
2. Explain processing stations and material handling systems used in FMS environments.
3. Understand tool management and analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.
4. Understand the concepts of group technology in FMS.
5. Design and analyze FMS using simulation and analytical techniques.

UNIT I UNDERSTANDING AND CLASSIFICATION OF FMS 9

Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications Flexibility in Pull and Push type Classification of FMS Layout - Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc

UNIT II PROCESSING STATIONS AND MATERIAL HANDLING SYSTEM 9

Processing stations: Salient features Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station. Material Handling System: An introduction, Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS)

UNIT III MANAGEMENT TECHNOLOGY 9

Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS

UNIT IV GROUP TECHNOLOGY 9

Introduction, Definition, Reasons for Adopting Group Technology, Benefits of Group Technology Affecting Many Areas of a Company, Obstacles to Application of GT

UNIT V DESIGN OF FMS 9

Performance Evaluation of FMS, Analytical model and Simulation model of FMS, Application of simulation – model of FMS– simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Classify and distinguish FMS and other manufacturing systems	Understand
CO2: Explain processing stations and material handling systems used in FMS environments	Understand
CO3: Understand tool management and analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS	Understand
CO4: Understand the concepts of group technology in FMS	Understand
CO5: Design and analyze FMS using simulation and analytical techniques	Apply

Text Book(s):

T1. Jha, N.K. “Handbook of flexible manufacturing systems”, Academic Press Inc., 2015.

T2. Groover, M.P “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India Pvt.Ltd. New Delhi 2009.

Reference(s):

R1. Reza A Maleki “Flexible Manufacturing system” Prentice Hall of Inc New Jersey, 2012.

R2. John E Lenz “Flexible Manufacturing” Marcel Dekker Inc New York, 2010.

Web References

1. https://nptel.ac.in/courses/112107143/36
2. https://nptel.ac.in/courses/112104228/31

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEEN1022	Course Title: ADVANCED COMPUTER INTEGRATED MANUFACTURING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Manufacturing technology

Course Objectives

The course is intended to:

1. Write NC, DNC and CNC program in CIM.
2. Design manufacturing solution based on CAD System in CIM.
3. Select Materials handling and Storage in CIM.
4. Write coding for Group Technology in CIM
5. Design automated manufacturing based on Artificial Intelligent system, Expert system and FMS in CIM.

UNIT I INTRODUCTION TO CIM 9

Automated Manufacturing system – Needs, Types.CIM - CIM wheel - Components, Evolution, needs, Benefits. NC system - Components, NC motion control system, application, advantages and disadvantages. Computer Numerical control System – Components, functions, advantages. Direct Numerical Control System – Components, functions, advantages.

UNIT II COMPUTER AIDED DESIGN 9

Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate. - typical CAD command structure - Types CAD modeling - wire frame modeling, surface modeling and solid modeling.

UNIT III MATERIAL HANDLING AND STORAGE SYSTEMS 9

Materials handling and Storage Systems - Automated storage and retrieval systems, carousel storage systems - Interfacing of Handling and Storage with Manufacturing system. AGVs - types, advantages and application. Robot – Basic concepts, applications.

UNIT IV GROUP TECHNOLOGY 9

Group Technology – Role of G.T in CAD/CAM Integration, part families, part Classification and coding–DCLASS and MICLASS and OPITZ coding systems - facility design using G.T, benefits of G.T -Cellular Manufacturing.

UNIT V ARTIFICIAL INTELLIGENT SYSTEM, EXPERT SYSTEM AND FMS 9

Artificial Intelligence System, Basic concepts of Artificial intelligence, Intelligent systems and expert systems. Flexible manufacturing systems – Configurations, workstations, planning, applications and benefits – Automated inspection and testing - Machine vision.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1:	Write program for NC, DNC and CNC in Automated Manufacturing systems such as CIM	Apply
CO2:	Design manufacturing solution with the features of CAD System such as Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate in design and modeling for CIM.	Apply
CO3:	Select appropriate Materials handling and storage systems such as AGVs, AS/RS and Robots for material handling and Storage System in CIM.	Apply
CO4:	Write codes using DCLASS, MICLASS and OPITZ for Group Technology in CIM.	Apply
CO5:	Design Automated Manufacturing based on Artificial Intelligent system, Expert system and FMS to gradually convert Traditional Manufacturing environment in CIM.	Apply

Text Books

T1. Mikell. P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education 2015.

T2. Mikell. P. Groover and Emory Zimmers Jr.,“CAD/CAM”, Prentice hall of India Pvt. Ltd., 2013.

References

R1. James A. Regh and Henry W. Kreabber, “Computer Integrated Manufacturing”, Pearson Education second edition, 2015.

R2. Chris McMahon and Jimmie Browne, “CAD CAM Principles, Practice and Manufacturing Management”, Pearson Education second edition, 2010.

R3. Ranky, Paul G., “Computer Integrated Manufacturing”, Prentice hall of India Pvt. Ltd., 2005.

Web References

1. https://en.wikipedia.org/wiki/Computer-integrated_manufacturing

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	2	1
CO2	3	2	1	1	-	-	-	1	-	1	-	1	2	1
CO3	3	2	1	1	-	-	-	1	-	1	-	1	2	1
CO4	3	2	1	1	-	-	-	1	-	1	-	1	2	1
CO5	3	2	1	1	-	-	-	1	-	1	-	1	2	1

High-3; Medium-2; Low-1

Course Code: 19MEEN1037	Course Title: SENSORS AND INSTRUMENTATION		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

- NIL

Course Objectives

The course is intended to:

1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
4. To learn about the optical, pressure and temperature sensor
5. To understand the signal conditioning and DAQ systems

UNIT I INTRODUCTION 9

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS 9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Recognize with various calibration techniques and signal types for sensors.	Understand
CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.	Understand
CO3: Apply the various sensors and transducers in various applications	Understand
CO4: Select the appropriate sensor for different applications.	Apply
CO5: Acquire the signals from different sensors using Data acquisition systems.	Apply

Text Book(s):

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.

2. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

Reference(s):

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons,Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April2001.
3. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford SciencePublications, 1999.
4. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRCPress, 2015.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEEC1013	Course Title: LOGISTICS ENGINEERING (Common to AU & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Pre-requisites:

- Manufacturing Processes

Course Objectives:

The course is intended to:

1. Assess the potential failure modes in material storage and handling between POM/POS to POC.
2. Apply REBA/RULA tools and techniques in storage and material handling design.
3. Verify produced part quality is delivered to the point of consumption.
4. Design material storage and handling system to prevent potential failure modes.
5. Develop standardized storage and handling work procedures.

UNIT I MATERIAL HANDLING - SYSTEMS AND FACILITIES 9

Material Handling System - Need, scope, definitions and terminologies, types, elements, Organization for logistics management and control. Introduction Process flow charting/mapping techniques.

Material Handling Facilities - Types of Material Handling Equipments (AGVs, Fork lift, prime movers, stackers, lifts etc), selection criteria for MHES. Design considerations, selection of materials. Estimation of number of facilities required; cost estimation and control. Introduction to thermoforming/injection molded crate design and manufacturing for kitting of the parts.

UNIT II ERGONOMICS IN DESIGN 9

Application of RULA & REBA in MHF design, MHF design considerations for plastic parts, painted Parts, machined parts, fragile parts, c class parts, inter-plant material movement, and in-direct areas.

UNIT III MEASURES OF MATERIAL HANDLING SYSTEM 9

Reliability, maintainability, serviceability, availability factors, Supply supports, TPM for MHF, manufacturing consideration: processes, methods and tools, assembly and dismantling of MHF, system feasibility analysis, system operational requirements, Supportability analysis, functional analysis, MTBF and MTTR for MHFs, flexibility in MHFs, traceability of MHFs and MHEs, salvaging of MHFs and MHEs

UNIT IV STORAGE SYSTEMS 9

Creation of modern stores and storage systems: concept of stores, types of stores, storage facilities, considerations for creation of stores, estimation of docks, truck turn-around time, truck window time, inventory and types, WIP, material retention point, model store concept

UNIT V ANALYSIS OF MATERIAL TRANSPORT SYSTEMS 9

Analysis of Vehicle based system- determination of number of vehicles in AGVs and determination of delivery distance. Conveyor analysis – single direction, continuous loop and re-circulating conveyors.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Identify the potential failure modes in material storage and handling between POM/POS to POC.	Understand
CO2: Use REBA/RULA tools and techniques to study ergonomics in storage and material handling design.	Understand
CO3: Verify produced part quality is delivered to the point of consumption.	Understand
CO4: Design material storage and handling system to prevent potential failure modes.	Apply
CO5: Develop standardized storage and handling work procedures	Apply

Text Book(s):

T1. MikelP.Groover, “Automation, Production Systems, and Computer-Integrated Manufacturing”, PHI Publishers, 3rd Edition 2016.

T2. Blanchard and Benjamin S, “Logistics Engineering and Management”, 6th International Edition, Prentice Hall Inc, 2015.

Reference Book(s):

R1. Christopher M, “Logistics and Supply Chain Management - Creating Value Adding Networks”, Prentice Hall, 2010.

R2. James M. Apple, “Plant Layout and Material Handling” John Wiley, 3rd Edition, 1977.

R3. PraussL,“The Green Multiplier - a Study of Environmental Protection and Supply Chain”, AntonnRauss Limited, Palgrave Macmillan, 2005.

R4. Taylor G.D, “Logistics Engineering handbook”, CRC Press, 2008.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="1">Course Code:19MEEC1001</td><td colspan="3">Course Title: PRODUCT LIFE CYCLE MANAGEMENT
(Common to AU, MC & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. To explain the fundamentals of PLM
2. To provide an in-depth understanding of business processes in the PLM.
3. To explain the management concept for product development in PLM.
4. To explain the importance of Digital Manufacturing in PLM.
5. To explain the use case scenarios through various customer case studies.

UNIT I BUSINESS STRATEGY IN THE PLM 9

Definition, PLM Lifecycle Model, Threads of PLM, Need for PLM, Opportunities and Benefits of PLM, Views, Components and Phases of PLM, PLM feasibility Study, PLM Visioning, Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.

UNITII BUSINESS PROCESSES IN THE PLM 9

Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM.
Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Workflow Management.

UNIT III PRODUCT DEVELOPMENT CONCEPTS IN THE PLM 9

Bill of Materials (E-BOM, M-BOM, S-BOM) and Process Consistency, Product Structure, Configuring BOM, Simulation Process Management, Variant Management, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.

UNIT IV DIGITAL MANUFACTURING IN THE PLM 9

Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-One, Ramp Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.

UNIT V CUSTOMER USE CASES OF THE PLM 9

Impact and Challenges faced while implementing a successful PLM strategy -Rolls Royce, Nissan Motor, Sunseeker International and Xtrac

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Understand PLM strategy based on the business needs	Understand
CO2: Explain various business processes in the PLM	Understand
CO3: Understand the product development concepts involved in the PLM	Understand
CO4: Explain the use of Digital Manufacturing environment in the PLM.	Understand
CO5: Understand the various customer use cases of the PLM	Understand

Text Book(s):

T1. John Stark, “Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation”, Springer International Publishing Switzerland, 3rd edition, 2015.

T2. Grieves Michael, “Product Lifecycle Management- Driving the Next Generation of Lean Thinking”, McGraw-Hill, 2010.

T3. Wang, Lihui; Nee, Andrew Y.C. (Eds.) Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.

Reference(s):

R1. Elangovan, U., “Product Lifecycle Management (PLM)”. Boca Raton, CRC Press, 2020.

R2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

R3. Antti Saaksvuori, “ Product Life Cycle Management” - Anselmi Immonen, Springer, 1st Edition, 2003.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO2	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO3	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO4	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO5	2	1	-	-	1	-	-	1	-	1	-	1	2	1

High-3; Medium-2; Low-1

Course Code: 19MEEC1023	**Course Title: MODEL BASED SYSTEMS ENGINEERING** (Common to AU, MC & ME)		
Course Category: Professional Elective		**Course Level: Introductory**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks:100**

Prerequisites

The student should have undergone the courses:

- Nil

Course Objective

The course is intended to

1. Explain the basis of system modeling
2. Explain the system specification
3. Develop a system architecture
4. Develop a handoff to downstream engineering
5. Demonstration of meeting needs

UNIT I BASICS OF SYSTEMS MODELING 9

Concept Generation and Selection-Product Architecture - Design for Manufacturing and Product Development– Managing backlog - Managing risk- Product roadmap- Release plan – Iteration plan – Estimating effort – Work item prioritization- Organizing your models.

UNIT II SYSTEM SPECIFICATION 9

Functional analysis with scenarios, activities, state machine and user stories- Model based safety and threat analysis- specific logical system interfaces – Creating the logical data schema- Technological forecasting.

UNIT III DEVELOPING SYSTEM ARCHITECTURES 9

General architectural guidelines – Architectural merging – Pattern driven architecture – Subsystem and component architecture – Architectural allocation - Creating subsystem interfaces.

UNIT IV HANDOFF TO DOWNSTREAM ENGINEERING 9

Preparation for handoff – Federating models for handoff – Logical to physical interfaces – Deployment architecture – Allocation to engineering facets – Interdisciplinary interfaces.

UNIT V VERIFICATION AND VALIDATION 9

Demonstration of meeting needs- Model simulation – Model based testing – Computable constraint modeling – Traceability – Effective reviews – Test driven models.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concept generation and selection of model based systems engineering.	Understand
CO2: Design the logical data schema based on the systems specifications using functional analysis.	Apply
CO3: Design the systems architectures for proper interface between sub systems and components.	Apply
CO4: Design the handoff using transformation of logical to physical interfaces and interdisciplinary interfaces.	Apply
CO5: Design the verification and validation phases for effective traceability and reviews.	Apply

Text Book

T1. Bruce Powel Douglass, "Agile Model-Based Systems Engineering Cookbook" ,Packt Publishing Ltd, UK, 1st edition, 2021.

T2. Tim Weikiens, Jesko G Lamm, Stephan Roth, Markus Walker ,"Model-Base Systems Architecture " , John Wiley & Sons, Inc., Hoboken, New Jersey, 1st edition, 2016.

References

R1. John Holt," Systems Engineering Demystified" ,Packt Publishing Ltd, UK, 1st edition, 2021.

R2. Andrew P Sage and James E Armstrong," Introduction to Systems Engineering", John Wiley & Sons, Inc., Hoboken, New Jersey, 1st edition, 2017.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO2	3	2	1	1	1	-	-	1	-	1	-	1	2	1
CO3	3	2	1	1	1	-	-	1	-	1	-	1	2	1
CO4	3	2	1	1	1	-	-	1	-	1	-	1	2	1
CO5	3	2	1	1	1	-	-	1	-	1	-	1	2	1

High-3; Medium-2; Low-1

Course Code:19MEEC1024	**Course Title: NEW PRODUCT DEVELOPMENT**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the courses:

- Manufacturing Technology
- Design of Machine Elements

Course Objectives

The course is intended to:

1. Understand the need of product development.
2. Identify the customer needs.
3. Select appropriate materials for a new product.
4. Select appropriate processes for a new product.
5. Understand the value analysis in costing.
6. Understand the Product Teardown.

UNIT I PRODUCT DEVELOPMENT 9

Need for developing products, the importance of engineering design, types of design, the design process. product lifecycle- relevance of product lifecycle issues in design, design using codes and standards. societal considerations in engineering design, fisher product classification, generic product development process, various phases of product development, planning for products, establishing markets, market segments, relevance of market research- market requirement specification and product requirement specification.

UNIT II PRODUCT MORPHOLOGY METHODS AND ANALYSIS 9

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- identify the technical requirement of customer need - establishing engineering characteristics. competitive benchmarking- quality function deployment- house of quality. product design specification- generating design concepts -systematic methods for design–functional decomposition – physical decomposition –functional representation. morphological methods and analysis -TRIZ- axiomatic design.

Unit III MATERIAL, AND MANUFACTURING PROCESS SELECTION 9

Selection of material for mechanical properties- Strength, toughness and fatigue- Material selection for durability, surface wear and Corrosion resistance- Functional relation between materials and processing. Manufacturing Processes - advantages and limitations. Selection of Processes- Process Capabilities - Design Guidelines. Product Design- Manufacturing Perspective.

UNIT IV VALUE ENGINEERING 9

Value Engineering Function- Approach of Function, Evaluation of Function, Determining Function, Classifying Function. Evaluation of costs- Evaluation of Worth, Evaluation of Value, FAST Diagram, categories of cost – overhead costs – activity based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing.

UNIT V PRODUCT TEARDOWN 9

Teardown Process- List Design Issues-Prepare for Product Teardowns, Examine the Distribution and Installation-Disassemble, Measure and Analyse Data by Assemblies, Form a Bill of Materials. Teardown methods-Subtract and Operate Procedure, Force Flow (Energy Flow Field) Diagrams, Measurement and Experimentation, product verification and validation, Case studies.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Design the various phases of product development based on the relevance of market research	Apply
CO2: Design the House of Quality to identify the customer needs and product design specification for a new product development.	Apply
CO3: Identify the appropriate materials and manufacturing process for a new product development based on manufacturing perspective.	Apply
CO4: Integrate the various functions of value engineering in new product development.	Apply
CO5: Examine the types Teardown process and methods using in new product development.	Apply

Text Book(s):

T1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, Product Design and Development, 6th Edition, 2019, Tata McGraw-Hill Education.

T2. Kevin Otto, Kristin Wood, Product Design, Indian Reprint 2018, Pearson Education.

T3. Anil Kumar Mukhopadhyaya, “Value Engineering: Concepts Techniques and applications”, SAGE Publications 2020.

Reference Book(s):

R1. Clive L.Dym, Patrick Little, Engineering Design: A Project-based Introduction, 3rd Edition, John Wiley and Sons, 2019.

R2. George E.Dieter, Linda C.Schmidt, Engineering Design, McGraw-Hill International Edition, 4th Edition, 2009.

R3. YousefHaik, T. M. M. Shahin, Engineering Design Process, 2nd Edition Reprint, Cengage Learning, 2010.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	-	1	-	2	2	1
CO2	3	2	1	1	1	1	1	1	-	1	-	2	2	1
CO3	3	2	1	1	1	1	1	1	-	1	-	2	2	1
CO4	3	2	1	1	1	1	1	1	-	1	-	2	2	1
CO5	3	2	1	1	1	-	-	1	-	1	-	2	2	1

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19MEEC1018</td><td colspan="2">Course Title: AUTOMOBILE ENGINEERING
(Common to MC & ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Applied Thermodynamics

Course Objectives:

The course is intended to:

1. Explain the vehicle structure and components.
2. Explain the IC Engines and lubricating systems.
3. Explain the construction and working principle of Transmission system.
4. Explain the construction and working principle of steering, braking and suspension system.
5. Explain electrical system, accessories and emission norms.

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles , vehicle construction and different layouts chassis, frame and body, resistances to vehicle motion and need for a gearbox, Introduction to IC Engines-types, working principles, components of engines-their forms functions and materials. Air bags- Air pollution control- Catalytic converter working principle-Emission norms- Bharat and Euro emission Standards

UNIT II FUELS AND LUBRICATION SYSTEM 9

Petrol fuel feed system: Feed pump – mechanical, electrical type – Carburetors – fixed venturi type (carter), variable venturi type (SU), multiple barrel type (Solex, Mikuni), carburetors for two wheelers -Petrol injection – Multi Point Fuel Injection (MPFI), VVT (petrol engines),Turbo chargers, Diesel fuel system: Jerk type fuel injection pump–Methods of fuel injection–common rail, distributor types-Nozzles–Cold starting aids, Cooling system: Direct and indirect cooling, Lubricating system: Mist, wet and dry sump. Ignition system- coil ignition and magneto ignition system – Spark plug

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction , gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel –torque converter, propeller shaft, slip joints, universal joints ,Differential, and rear axle, Hotchkiss Drive and Torque Tube Drive

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System and Traction Control. Battery –Construction and maintenance, Starter motor –types, alternator, distributor, generator, cut out relay, panel board instruments

UNIT V ELECTRIC VEHICLE 9

EV Historical background, Benefits of using EVs, comparison with IC engine drive vehicles, Types of EVs, Motor drive technology, Energy sourcing, and charging technology, EV charging standards-V2G, G2V, V2B, and V2H, EV subsystem and configuration, Introduction to Hybrid electric vehicle,

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the vehicle structure chassis layouts and different types of IC Engines	Understand
CO2: Describe the fuels and lubrication system used in SI & IC engines. viz carburetors, APFI, VVT, Turbo charger, CRDI, Lubrication system viz mist, wet and dry sump system	Understand
CO3: Explain the construction and working principle of various components of a Transmission system viz gear box,, clutch, torque converter, fluid flywheel, differential etc.	Understand
CO4: Describe the construction and working principle of steering and suspension system of a Automotive vehicle	Understand
CO5: Explain the electrical vehicle and its sub systems.	Understand

Text Book(s):

T1. Kirpal Singh, “Automobile Engineering Vol. 1 &Vol 2”, Standard Publishers, 7th Edition, 2012.

T2. Sethi H.M, “Automobile Technology”, Tata McGraw-Hill, 2003.

Reference(s):

R1. Jain, K.K., and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.

R2. Srinivasan.S, “Automotive Mechanics” 2nd edition, Tata McGraw-Hill, 2003.

R3. Joseph Heitner, “Automotive Mechanics”, 2nd edition, East-West Press, 1999.

Web References:

1. https://en.wikipedia.org/wiki/Automotive_engineering
2. http://auto.howstuffworks.com/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19MEEC1003</td><td colspan="3">Course Title: VIBRATION AND NOISE ENGINEERING
(Common to MC & ME)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the courses:

- Theory of Machines

Course Objectives

The course is intended to:

1. Calculate the natural frequency of the given systems.
2. Calculate natural frequency of continuous system using approximate methods.
3. Identify the required vibration measuring instruments.
4. Calculate the basic noise parameters from the given condition.
5. Analyze the industrial noise and apply the control techniques.

UNIT I BASICS OF VIBRATION 9

Introduction, classification of vibration: free and forced vibration, linear and non-linear vibration, response of damped and undamped systems under harmonic force, Free and forced vibration of multi-degree of freedom systems.

UNIT II VIBRATION OF CONTINUOUS SYSTEMS 9

Vibration of continuous systems: exact methods, boundary value problem, Eigen value problem, axial vibration of rods, transverse vibration of beams, response of system by modal analysis, General elastic waves, approximate methods to analyse system, different methods like Rayleigh's energy method, Rayleigh-Ritz method, Dunkerley's method.

UNIT III VIBRATION ANALYSIS AND CONTROL TECHNIQUES 9

Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of

Sensors- Accelerometer Mountings. –Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments.

UNIT IV BASICS OF NOISE 9

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise level, legislation, measurement and analysis of noise, measurement environment and equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT V INDUSTRIAL NOISE AND CONTROL 9

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise. Introduction to -Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Calculate the natural frequency of the given systems.	Apply
CO2:	Calculate natural frequency of continuous system using approximate methods like Rayleigh's energy method, Rayleigh-Ritz method and Dunkerleys method.	Apply
CO3:	Identify the required measuring instruments for vibration analysis in engine system.	Apply
CO4:	Calculate the basic noise parameters from the given condition.	Apply
CO5:	Analyze the industrial noise and apply the control techniques in automobile.	Apply

Text Book(s):

T1. Ambekar A.G. “Mechanical Vibrations and Noise Engineering” Prentice Hall of India Pvt. Ltd, 2008.

T2. SingiresuS.Rao - “Mechanical Vibrations” - Pearson Education, 6th edition, 2018.

Reference(s):

R1 Rao V. Dukkipati&Srinivas J. “Mechanical Vibrations” - Prentice Hall of India Pvt. Ltd, 2008.

R2 Kewal Pujara “Vibrations and Noise for Engineers, Dhanpat Rai& Sons, 1992.

R3 W.T.Thomson, “Theory of Vibrations with applications”,CBS Publishers,2002.

R4 Rao, J.S., & Gupta, K. “Ind. Course on Theory and Practice Mechanical Vibration”, New Age International (P) Ltd., 1999.

R5 Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa, New Delhi, 2000.

Web References:

1. http://nptel.ac.in/courses/112107088/
2. http://nptel.ac.in/courses/112104040/
3. http://www.journals.elsevier.com/journal-of-sound-and-vibration/most-downloaded-articles/
4. http://www.kineticsnoise.com/industrial/
5. http://www.nerc.ac.uk/about/policy/safety/procedures/procedure-vibration/
6. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290397/sp4-079-tr-1-e-e.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEEC1021		Course Title : JAVA PROGRAMMING FOR MECHANICAL SCIENCES (Common to AU, ME)	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0:	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Describe the distinct properties and features of Java.
2. Implement name spaces, concurrency and handle exceptional conditions.
3. Employ Java standard library functions.
4. Apply Java utility, input/output functions and file manipulators.
5. Develop Java applications using user interfaces and database connectivity.

UNIT I INTRODUCTION 9

Overview of Java – Data types, operators, control flows –Class fundamentals, objects and constructors –Method overloading- argument passing, Returning objects, recursion – Method Overriding and Dynamic Method dispatch- Abstract class.

UNIT II PACKAGES, EXCEPTIONS AND THREADS 9

Packages and access protection – Interfaces and extending interfaces – Exception fundamentals and types – Try, catch, throw, throws and finally; Chained Exceptions – Thread model, Creating threads and thread priorities – Synchronization –Inter thread communication.

UNIT III JAVA UTILITIES 9

String Handling –String Buffer class and functions – Library Functions – Math – Process – Clone – System Functions.

UNIT IV COLLECTIONS AND I/O STREAMS **9**

Collections – Classes and Interfaces – Iterators and User defined collections – String Tokenizer – Java I/O classes and Interfaces - Streams – Byte Streams - Character Streams – File concepts.

UNIT V EXPLORING SWING **9**

Java Swing – Features –Components and Containers – Event handling – Exploring Swing – Menus – Java Database Connectivity.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the distinct properties and features of Java	Understand
CO2: Implement name spaces, concurrency and handle exceptional conditions in programs	Apply
CO3: Employ Java standard library functions for solving complex problems	Apply
CO4: Apply Java utility, input/output functions and file manipulators	Apply
CO5: Develop Java applications using user interfaces and database connectivity.	Apply

Text Book(s):

T1. Herbert Schildt, "Java the Complete Reference", Mcgraw Hill Education, Ninth Edition, 2014

T2. Mahmoud Parsian, "JDBC Metada, MySQL and Oracle Recipes: A Problem-Solution Approach", Apress Publications, 2016.

Reference Book(s):

R1. Bart Baesens, Aimee Backiel, SeppeVandenBrocke, "Beginning Java Programming: The Object Oriented Approach", John Wiley & Sons, 2015.

R2. Daniel Liang, "Introduction to Java Programming, Comprehensive Version", Pearson Education, Ninth Edition, 2014.

R3. James M Slack, Programming and Problem solving with JAVA, Thomson Learning, 2002.

Web Reference:

1. https://docs.oracle.com/javase/tutorial/java/index.html
2. http://javabeginnerstutorial.com/core-java/
3. http://www.w3schools.in/java/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	1	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19SCEC2001	**Course Title: Cyber Security** **(common to all B.E/B.Tech programmes)**		
Course Category: Professional Elective		**Course Level: Introductory**	
L:T:P (Hours/Week) **2: 0: 2**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Discuss the various concepts in Cyber security and infrastructures involved.
2. Describe the cyber-crimes, reporting procedures and legal remedies.
3. Explain various social media related security issues and reporting flaws.
4. Explain various settings related to E-Commerce and Digital payments.
5. Demonstrate the security aspects related to digital devices and technology.

Unit I Introduction to Cyber Security 9 Hours

Defining Cyberspace and Overview of Computer and Web-technology - Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Unit II Cyber crime and Cyber law 9 Hours

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organizations dealing with Cyber crime and Cyber security in India, Case studies.

Unit III Social Media Overview and Security 9 Hours

Introduction to social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

Unit IV E-Commerce and Digital Payments 9 Hours

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payment Settlement Act, 2007.

Unit V Digital Devices Security, Tools and Technologies for Cyber Security 9 Hours

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the concept of Cyber Security and infrastructure involved.	Understand
CO2: Develop procedures for reporting various cyber-crimes through available platforms.	Apply
CO3: Demonstrate various social media related security issues and reporting flaws.	Apply
CO4: Illustrate various settings in e-commerce and digital payment applications.	Apply
CO5: Demonstrate the digital devices security, tools and technologies for cyber security.	Apply

Text Book(s)

T1. Cyber Crime Impact in the New Millennium, R. C Mishra. Auther Press.T2, 2010
T2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, 1st Edition, Wiley India Pvt. Ltd, 2011.

T3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by

Henry A. Oliver, Create Space Independent Publishing Platform, PearsonEducation, 2001.

Reference Book(s)

R1. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition,Wiley India Pvt. Ltd, 2001
R2. Security Fundamentals of Network by E. Maiwald, McGraw Hill ,2014
R3. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K,Dominant Publishers, 2011.

Web Reference(s):

1. https://unacademy.com/content/upsc/study-material/science-and-technology/initiatives-taken-by-indian-government-for-cyber-security/
2. https://cybercrime.gov.in/
3. https://www.meity.gov.in/cyber-security-division
4. https://intellipaat.com/blog/what-is-cyber-security/

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	3	3	3	-	1	-	-	3	-
CO2	-	-	-	2	-	3	3	3	3	2	-	-	3	-
CO3	-	-	-	2	-	3	3	3	3	2	-	-	3	-
CO4	1	-	1	3	2	3	2	3	3	2	-	2	3	3
CO5	1	-	1	3	2	3	2	3	-	1	-	3	3	3

High-3; Medium-2;Low-1

<table>
<tr><td rowspan="2">Course Code:19MEEC1022</td><td colspan="3">Course Title : DATA STRUCTURES AND OBJECT ORIENTED PROGRAMMING WITH C++
(Common to AU, ME)</td></tr>
<tr></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Write simple C++ programs.
2. Write advanced C++ programs.
3. Implement linear data structures and sorting & searching algorithms.
4. Implement non-linear data structures such as Trees and Graphs.
5. Explain Data mining in Knowledge discovery process.

UNIT I PRINCIPLESOFOBJECTORIENTEDPROGRAMMING **8**

Introduction-Tokens-ControlStructures– Functions& Pointers –Concepts of OOP - Classes and Objects - Constructors and Destructors- Inheritance.

UNIT II ADVANCED OBJECT ORIENTED PROGRAMMING **9**

Polymorphism – Overloading: Function loading & Operator overloading - Overriding- Virtual Functions –FileHandling: Read & Write operations – Introduction to Exception Handling.

UNIT III LINEARDATASTRUCTURES **11**

lgorithm Analysis-Abstract Data Types-List ADT-array and Linked List Implementation–Stack ADT - Queue ADT– Applications of Linear Data structure -Sorting Techniques: Bubble sort - Merge sort-Quick sort-Searching Techniques:Linear Search–Binary Search.

UNIT IV TREES AND GRAPHS **9**

Trees: Binary Trees-Binary Search Tree ADT - Graph Algorithms: Topological Sort-Single Source Shortest Path Algorithm-All Pairs Shortest Path Algorithm - Minimum Spanning Tree - Prim's and Kruskal's Algorithm.

UNIT V- INTRODUCTION TO DATA MINING **8**

Data Mining Overview – Knowledge Discovery in Databases process – Different Kinds of Data – Kinds of Patterns Mined – Technologies Used – Kinds of Applications – Issues in Data Mining – Data Warehouse Basic Concepts.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Write C++ programs using classes, objects and Inheritance paradigms.	Apply
CO2: Write C++ programs using polymorphism, File and Exception handling operations.	Apply
CO3: Implement linear data structures and sorting& searching algorithms.	Apply
CO4: Implement non-linear data structuressuch as Trees andGraphs.	Apply
CO5: Explain Data mining in Knowledge discovery process and its applications.	Understand

Text Book(s):

T1. Robert Lafore, “Object Oriented Programming in C++”, Sams Publishing, Fourth edition, 2002.

T2. MarkAllenWeiss,“DataStructuresandAlgorithmAnalysisinC”,PearsonEducation Asia, New Delhi, Third Edition, 2007.

T3. JiaweiHan, MichelineKamber, JianPei “Data Mining Concepts and Techniques”, Elsevier,ThirdEdition, 2012.

Reference Book(s):

R1. Balagurusamy.E,“ObjectOrientedProgrammingwithC++”,TataMcGrawHill, New Delhi, Fourth Edition,2008.

R2. Alfred V.Aho,JohnE. Hopcroft and Jeffry D.Ullman, “Data Structures and Algorithms”, Pearson Education, New Delhi, 2006.

R3. Ellis Horowitz, Sartaj Sahni,Dinesh Mehta “Fundamentals of Data Structures inC++”, Galgotia Publication, NewDelhi, Third Edition, 2009.

R4. Seymour Lipschutz, “Data Structures”, McGraw-Hill,NewDelhi, Third Edition,2007.

R5. Michael Berthold, David.J.Hand, “Intelligent Data Analysis”, Springer, Second Edition, 2007.

Web Reference:

1. https://nptel.ac.in/courses/117/103/117103063/
2. https://nptel.ac.in/courses/108/108/108108111/
3. https://nptel.ac.in/courses/108/104/108104091/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	1	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	1	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEEC1006	Course Title: AUTOMOTIVE ENGINE AND ITS SYSTEMS (Common to MC & ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Thermal Engineering

Course Objectives

The course is intended to:

1. Explain the construction details of the power train.
2. Describe the combustion and emission characteristics of IC engines.
3. Describe the functions of various engine subsystems.
4. Interpret the performance characteristics of the vehicle.
5. Examine various advanced engines and alternate fuels.

UNIT I INTRODUCTION TO POWER TRAIN 9

Power train – Types – Engine (SI and CI) – Torque converter – Valve train layout & crank train layout- valve timing and timing chain layout – Piston components – importance of B/S and L/r – Crank offset.

UNIT II COMBUSTION AND EMISSION IN IC ENGINES 9

Chemistry of combustion, Stoichiometric equations of combustion – Introduction to SI and CI combustion – Engine knocking – Combustion chamber and its types –Combustion chamber design – Temperature – Fuel (include load /speed) – Fuel properties/characteristics (temperatures, Octane, Cetane no. etc) – Emission norms (Indian, European – US emission norms – Emission testing and certification) – Fuel Norms(BS1, BS2) – Environmental effects of Emissions – Emission relation with AFR – After treatment devices (include SAI,2WC), Chemical reactions involved in after treatment.

UNIT III ENGINE SUBSYSTEMS 9

Energy balance and cooling load estimation – Typical operating temperatures of engine parts – Types of cooling system – Cooling system design (Air cooled and water cooled) – Schematic layout of Cooling system for a two wheeler engine – Engine friction – Lubrication requirements of engine – Functions of Lubricating oil – Parts to be lubricated and not to be lubricated – Schematic layout of lubricating system – Oil filtering – Lubricating oils, types and properties – Functions of induction system – Schematic layout (2W and 4W) – Air Filtering and its importance – Exhaust and after treatment – Functions of exhaust system – Muffler layout – Schematic layout of exhaust system (2W and 4W)..

UNIT IV PERFORMANCE CHARACTERISTICS 9

Volumetric efficiency – Factors affecting volumetric efficiency, ram effect, engine tuning, Fuel control systems (Carburetor, Fuel Injection) – Meeting demands of Vehicle (drivability, emissions and fuel economy) by controlling air and fuel – sensors – Vehicle performance characteristics, Road resistance, Wheel force in different gears, predict acceleration from engine performance graph – Various relations between AFR, Ignition timing and injection timing – Emission, performance (fuel consumption) – Sensors and devices used for performance and emission measurements.

UNIT V ADVANCED ENGINE CONCEPTS 9

Engines (Wankel, six stroke, lean burn, GDI, HCCI etc.) Hybrid vehicles – VVT, Turbo/super charging – Benefits of different engine concepts – Alternate fuels, compare performance – Fuel economy & emission with fuels (alcohol, vegetable oils, LPG, CNG etc.) – Limiting factors and practical problems.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Explain the construction details of the power train such as Valve & crank train layout used in four stroke IC engines.	Understand
CO2: Describe the combustion characteristics such as chemistry, knocking, temperature & fuel and emission characteristics such as norms, environmental effects, after treatment devices of four stroke IC engines.	Understand
CO3: Describe the functions of various engine subsystems such as cooling system, induction system and exhaust system of an automobiles.	Understand
CO4: Interpret the performance characteristics like volumetric efficiency, ram effect, engine tuning, Fuel control systems of the vehicle considering the relationship between volumetric efficiency of engine and emission norms.	Understand
CO5: Examine various advanced engines like Wankel, lean burn, GDI, HCCI and alternate fuels like alcohol, vegetable oils, LPG, CNG used in automobiles.	Understand

Text Books:

T1. Edward F. Obert, “Internal Combustion Engines and Air Pollution” First Edition, Addison-Wesley Educational Publishers, Incorporated, reprint, 2012.

T2. V. Ganesan, “Internal Combustion Engines” McGraw-Hill, reprint 2012.

Reference Books:

R1. John B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw-Hill, reprint 2012.

R2. Richard Stone, “Introduction to Internal Combustion Engines”, Third edition, Society of Automotive Engineers, Incorporated 1999.

Web References:

1. https://en.wikibooks.org/wiki/Automotive_Systems
2. https://bajatutor.net/online-baja-crash-course-for-atv-enthusiasts/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEEC2001		Course Title: MECHANICAL ENGINEERING DESIGN AND AUTOMATION (COMMON TO AU, CE,ME)	
Course Category: Elective		Course Level: Mastery	
L:T:P(Hours/Week) 2: 0: 2	Credits:3	Total Contact Hours:60	Max Marks:100

Course Objectives:

The course is intended to

1. Understand the need of new product design and development.
2. Select appropriate materials and manufacturing processes for a new product.
3. Understand the value engineering principles and techniques.
4. Understand the principles and methodologies of DFx.
5. Understand the system models and architecture using MBSE.

UNIT I Product Design Overview and Techniques 6 Hours

Importance of engineering design - Product life cycle - Design process – Requirement engineering - Conceptual design – Virtual Validation – CAE (FEA & CFD) - Detail Design – Prototyping - Standards – Concurrent Engineering - Technological Forecasting - Market Identification - Systems Engineering – MBD -Human Factors in Design - Industrial Design - Design Techniques: Brainstorming, TRIZ, QFD, Pugh matrix – Creativity and Problem Solving - Industry Case Studies - Hands-on Projects.

UNIT II Material and Manufacturing Process 6 Hours

Selection of material for mechanical properties- Strength, toughness and fatigue- Material selection for durability, surface wear and Corrosion resistance- Functional relation between materials and processing. Manufacturing Processes - advantages and limitations. Selection of Processes- Process Capabilities - Design Guidelines. Product Design- Manufacturing Perspective - Industry Case Studies - Hands-on Projects.

UNIT III Value Engineering and Product Benchmarking 6 Hours

Value Engineering Function- Approach of Function, Evaluation of Function, Determining Function, Classifying Function. Evaluation of costs- Evaluation of Worth, Evaluation of Value, FAST Diagram, Should costing - categories of cost – overhead costs – activity-based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing. Product Benchmarking - Teardown Process- List Design Issues-Form a Bill of Materials - Teardown methods- Measurement - product verification and validation - Industry Case Studies - Hands-on Projects.

UNIT IV Design for Excellence (DFx) **6 Hours**

Importance of DFx - DFx Principles and Methodologies- Design for Manufacturing (DFM) - Design for Assembly (DFA) - Design for Reliability (DFR) - Design for Safety (DFS) - Design for Sustainability (DFS) - Design for Cost (DFC) - Tools and Techniques - Case Studies and Practical Applications - Hands-on Projects.

UNIT V Introduction of Next Gen Technologies **6 Hours**

Overview of MBSE - SysML – Python - Core Concepts of MBSE: System Models and Architecture, Requirements Engineering, System Design and Analysis, Verification and Validation - General architectural guidelines – Subsystem and component architecture – Parametric Modeling - Generative Design - MBSE Tools - Practical Applications and Case Studies

List of Experiments **30 Hours**

1.Product dissection experiment on multiple products.

2.Development of coffee machine using MBSE approach.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1:Apply various engineering design methods and techniques to generate, select and evaluate design concepts.	**Apply**
CO2: Apply the concepts of material properties and various manufacturing processes and evaluate their suitability for different product designs.	**Apply**
CO3: Apply value engineering principles and techniques to optimize product or system functionality and cost.	**Apply**
CO4: Apply the principles and methodologies of DFx	**Apply**
CO5: Apply system models and architecture using MBSE.	**Apply**

Text Book(s):

T1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, Product Design and Development, 6th Edition, 2019, Tata McGraw-Hill Education.

T2. Kevin Otto, Kristin Wood, Product Design, Indian Reprint 2018, Pearson Education.

T3. Bruce Powel Douglass, “Agile Model-Based Systems Engineering Cookbook”, Packt Publishing Ltd, UK, 1st edition, 2021.

Reference Book(s):

R1. Kevin Otto, Kristin Wood, Product Design, Indian Reprint 2018, Pearson Education.

R2. George E.Dieter, Linda C.Schmidt, Engineering Design, McGraw-Hill International Edition, 4th Edition, 2009.

R3.John Holt, “Systems Engineering Demystified”, Packt Publishing Ltd, UK, 1st edition, 2021.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	1	-	1	-	1	2	1
CO2	3	2	1	-	1	-	-	1	-	1	-	1	2	1
CO3	3	2	1	-	1	-	-	1	-	1	-	1	2	1
CO4	3	2	1	-	1	-	-	1	-	1	-	1	2	1
CO5	3	2	1	-	1	-	-	1	-	1	-	1	2	1

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code:19MEEC2002</td><td colspan="3">Course Title: PLM FOR ENGINEERS
(Common to All)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 2: 0: 2</td><td>Credits:3</td><td>Total Contact Hours:60</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. To explain the fundamentals of PLM
2. To provide an in-depth understanding of business processes in the PLM.
3. To explain the management concept for product development in PLM.
4. To explain the importance of Digital Manufacturing in PLM.
5. To explain the use case scenarios through various customer case studies.

UNIT I BUSINESS STRATEGY IN THE PLM 6

Definition, PLM Lifecycle Model, Threads of PLM, Need for PLM, Opportunities and Benefits of PLM, Components and Phases of PLM, PLM feasibility Study, PLM Visioning, Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment.

UNITII BUSINESS PROCESSES IN THE PLM 6

Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM.
Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Workflow Management.

UNIT III PRODUCT DEVELOPMENT CONCEPTS IN THE PLM 6

Bill of Materials (E-BOM, M-BOM, S-BOM) and Process Consistency, Product Structure, Configuring BOM, Simulation Process Management, Variant Management, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.

UNIT IV DIGITAL MANUFACTURING IN THE PLM 6

Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-One, Ramp Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.

UNIT V CUSTOMER USE CASES OF THE PLM 6

Impact and Challenges faced while implementing a successful PLM strategy -Rolls Royce, Nissan Motor, SunseekerInternational ,Xtrac,Kesslers international and Monier and Weatherford international.

List of Experiments 30

1. Demonstrate the 2-Tier & 4-Tier Architectures and Basic Teamcenter applications like Organization, Project, and Schedule Manager.

2.Create CAD and Non-CAD datasets (MS Office, Notepad, etc.) by using explicit and implicit Check-In and Check-Out to create multiple iterations.

3. Create the access control (Read, Write, and Delete) for the given dataset and block the access rights to other group members belongs to the same department. Also Perform the Impact Analysis (Where Used and Where Referenced) of a given dataset which is used in multiple assemblies.

4.createthe Product Structure in Structure Manager with 5 components assembled in first level and 3 components Assembled in second, third and fourth level with the sub-assemblies and export the assembly in local drive. Also, demonstrate the Variant Management.

5.Export the CAD dataset as a JT file and perform the various visualization tasks like Measurements, Sectioning, PMI, and Mark-up using JT2GO application.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Understand PLM strategy based on the business needs	Understand
CO2: Explain various business processes in the PLM	Understand
CO3: Understand the product development concepts involved in the PLM	Understand
CO4: Explain the use of Digital Manufacturing environment in the PLM.	Understand
CO5: Understand the various customer use cases of the PLM	Understand

Text Book(s):

T1. John Stark, "Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation", Springer International Publishing Switzerland, 3rd edition, 2015.

T2. Grieves Michael, "Product Lifecycle Management- Driving the Next Generation of Lean Thinking", McGraw-Hill, 2010.

T3. Wang, Lihui; Nee, Andrew Y.C. (Eds.) Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.

Reference(s):

R1. Elangovan, U., "Product Lifecycle Management (PLM)". Boca Raton, CRC Press, 2020.

R2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

R3. AnttiSaaksvuori, " Product Life Cycle Management" - AnselmiImmonen, Springer, 1st Edition, 2003.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO2	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO3	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO4	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO5	2	1	-	-	1	-	-	1	-	1	-	1	2	1

High-3; Medium-2; Low-1

Course Code: 19AUEC1006	Course Title: ELECTRONIC STEERING SYSTEM (Common to ME & AU)		
Course Category: Professional Elective		Course Level: Introductory	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Course objective:

Course is intended to:

1. Understand the materials properties and manufacturing processes used for various components of steering system
2. Calculate the kinematic parameters of mechanisms and design shafts & bearings used in steering systems
3. Explain the use of various type of sensors, transducers and actuators used in steering systems.
4. Explain the various types of motors used in steering systems.
5. Explain the use of various controllers and communication devices used in steering system

Unit I Materials and Manufacturing 9 Hours

Materials for steering system - Material Properties - Ferrous and Non-Ferrous Alloys, rubber, plastics and polymer.

Manufacturing processes: Casting - pressure die casting (aluminium die-casting), plastic injection and rubber moulding and types of plastic moulding processes, Metal forming - forging, tube forming-axial forming, swaging, hydro forming, Metal Joining processes, Additive manufacturing, Rapid Prototyping, Powder Metallurgy, Heat Treatment methods.

Unit II: Mechanics of Steering Systems **9 Hours**

Free body diagram, unknown force, moment, torque calculations for worst case scenarios for steering components.

Torsion calculations for circular and non-circular sections. Stress calculations for worst case scenarios for steering column and sheet metal parts used in steering system.

Unit III: Drawing Standards **6 Hours**

Drawing standards, Limits, Fits and Tolerances, ASME14.5 standards, Geometric Dimensioning &Tolerance.

Unit IV : Introduction to Steering System **8 Hours**

Types of steering systems - Mechanical and power assisted steering systems, steering handling characteristics- under steer, over steer, neutral steer. Forces - side force, lift force, drag force- moments- yaw, roll, pitch and bounce.

Unit V: Basic Electrical systems for Steering **13 Hours**

Basics of electrical Quantities - DC Circuits, AC Circuits.

Sensors: Types-inductive, hall, moving magnet type, sensors used for steering system, LIDAR, RADAR, Camera. Transducers - Classification – Selection and specification of transducers.

Motors-Types, working and characteristics - Brushed DC machine, Brushless DC machine, Induction machine, PMSM machine, buck, boost, buck-boost converters, MOSFET.

Microcontrollers-Architecture, Automotive microcontrollers-Renasas, Infenion, Hella, Bosch, Microcontroller datasheet, Automotive cyber security, functional safety.Electronic control Unit– open-source ECU.

Project Management – Overview, PERT and CPM chart. (Delivery through Guest Lecture/workshop).

Course Outcomes: At the end of the course students will be able to:	Cognitive Level
CO1. Explain the various materials and manufacturing processes used for fabrication of various components of steering system.	U
CO2. Apply the concepts of stresses at a point in a material of structural elements.	Ap
CO3. Determine various forces on rigid bodies under static conditions.	Ap
CO4. Understand the types, components and functions of steering system.	U
CO5. Explain the functions of various electrical components and devices used in steering system.	U

Text Book(s):

T1. Manfred Harrer, Peter Pfeffer, Steering hand book Springer 2016.

T2. Robert Bosch "Automotive Electrics and Automotive Electronics", 5th edition, 2007.

T3. Hibbeler, "Engineering Mechanics-Statics & Dynamics" – Pearson Publications, 14th edition, 2017.

Reference Book(s):

R1. Robert Bosch GmbH, Automotive Handbook, 11th edition, 2022.

R2. Konrad Reif, Automotive Mechatronics, Springer Publications, 2015.

R3. Dr.Yasir Imtiaz Khan, Automotive Cyber Security Challenges-A Beginners Guide,

Amazon Digital Services, 2020.

Web Reference(s):

- https://www.bosch-mobility.com/en/solutions/steering/electric-power-steering-systems/

Course Code:19MEOC1001	Course Title: AUTOMATION SYSTEMS		
Course Category: Open Elective		Course Level: Introductory	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Describe the need of automation
2. Describe various pneumatic control elements
3. Describe the parts of PLC
4. Describe the PLC programming
5. Analyze different type of automation systems

UNIT I FUNDAMENTAL CONCEPTS OF AUTOMATION 9

History and developments in industrial automation, vertical integration of industrial automation, fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, and levels of automation control elements in industrial automation

UNIT II PNEUMATIC SYSTEMS 10

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and integration - sequential circuits - cascade methods - step counter method. Electrical elements to control pneumatic equipments - selection of components - design calculations -application - fault finding – low cost automation - robotic circuits.

UNIT III BASICS OFPROGRAMMABLE LOGIC CONTROLLERS 9

Basics of PLC, advantages, capabilities of PLC, architecture of PLC, scan cycle, types of plc, types of i/o modules, configuring a plc, plc wiring

UNIT IV PLC PROGRAMMING 10

Types of programming - simple process control programs using relay ladder logic - PLC arithmetic functions - timers and counters –data transfer-comparison and manipulation instructions

UNIT V CASE STUDIES 7

Case studies of machine automation, process automation, and selection parameters for PLC and real time interfacing.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Describe the need of automation for industrial applications	Understand
CO2: Describe various pneumatic control elements for low cost automation.	Understand
CO3: Describe the functional parts of PLC used for automation	Understand
CO4: Develop logic programmes for real time applications using PLC	Understand
CO5: Analyze different type of systems such as machine and process automation	Understand

Text Book(s):

T1. Esposito Anthony, “Fluid Power with Applications”, Pearson education Inc., New York, 2013.

T2. Petruzella, Frank D, ”Programmable logic controllers”, McGraw-Hill Companies, Inc, 2018.

Reference(s):

R1. Devadas Shetty and Richard A.Kolk, “Mechatronics Systems Design”, Cengage Learning Inc, 2010.

Web references

1. https://en.wikipedia.org/wiki/mechatronics
2. http://www.cedrat.com/en/publications/categories/devicesystems/systems/mechatronics.html
3. http://nptel.ac.in/courses/112103174/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO2	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO3	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO4	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO5	1	1	-	-	-	-	-	2	1	2	-	1	2	-

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code:19MEOC1002</td><td colspan="3">Course Title: ENTREPRENEURSHIP DEVELOPMENT</td></tr>
<tr><td colspan="2">Course Category: Open Elective</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Describe the requirement of entrepreneurship.
2. Explain the different motivational theories and government policies.
3. Classify the types of enterprises
4. Explain the various processes in managing an enterprise
5. Explain the government norms and policies

UNIT I ENTREPRENEURSHIP 9

Definition, requirements to be an entrepreneur, entrepreneur and manager, growth of entrepreneurship in India, women entrepreneurship, rural and urban entrepreneurship.

UNIT II ENTREPRENEURIAL MOTIVATION 9

Motivating factors, motivation theories-Maslow's Need Hierarchy Theory, McClelland's Acquired Need Theory, government's policy actions towards entrepreneurial motivation, entrepreneurship development programmes.

UNIT III TYPES OF ENTERPRISES AND OWNERSHIP STRUCTURE 9

Small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance.

UNIT IV MANAGEMENT OF ENTERPRISES 9

objectives and functions of management, scientific management, general and strategic management; introduction to human resource management: planning, job analysis, training, recruitment and selection, etc.; marketing and organizational dimension of enterprises; enterprise financing : raising and managing capital, shares, debentures and bonds, cost of capital; break- even analysis, balance sheet its analysis..

UNIT V INSTITUTIONAL SUPPORT AND POLICIES 9

Institutional support towards the development of entrepreneurship in India, Technical consultancy organizations, government policies(MSME) for small scale enterprises.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Describe the requirements for entrepreneurship	Understand
CO2:	Explain different motivational theories and policies for entrepreneur development	Understand
CO3:	Explain the types of enterprises and ownership structure	Understand
CO4:	Explain the various processes in managing an enterprise	Understand
CO5:	Explain the government norms and policies that govern small scale enterprises	Understand

Text Book(s):

T1. Ram Chandran, "Entrepreneurial Development", 1st edition, Tata McGraw Hill, New Delhi, 2008.

T2. Khanka, S S. "Entrepreneurial Development", 7th edition, S Chand & Company Ltd. New Delhi, 2020.

Reference Book(s):

R1. Saini, J. S., "Entrepreneurial Development Programmes and Practices", 2nd edition, Deep & Deep Publications (P), Ltd, 2001.

R2. Badhai, B "Entrepreneurship for Engineers", DhanpatRai& co. Ltd, 2013.

R3. Desai, Vasant, "Project Management and Entrepreneurship", Himalayan Publishing House, Mumbai, 2013.

Web References

1. http://www.ediindia.org/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO2	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO3	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO4	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO5	1	1	-	-	-	-	-	2	1	2	-	1	-	-

High-3; Medium-2; Low-1

1.

Course Code: 19MEOC1003	Course Title: TELEMATICS FOR TRANSPORT		
Course Category: Open Elective		**Course Level: Introductory**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives:

The course is intended to:

1. Develop knowledge on the Vehicle Telematics and its Working and applications
2. Develop knowledge on the Rail automation and transport
3. Develop knowledge on Rail Telematics
4. Develop knowledge on the Telematics Devices
5. Develop knowledge on the Telematics best practices & real-world challenges

UNIT I INTRODUCTION TO VEHICLE TELEMATICS 9

Overview of Vehicle Telematics -Telematics Architecture- Services and Applications - Vehicle Safety and Security

UNIT II RAIL AUTOMATION AND TRANSPORT 9

Technical specification for interoperability (TSI) for telematics applications for passenger services (TAP). Regulations- TSI-TAP- Telematics applications for freight services- Implementation and Application of Telematics in Rail Business

UNIT III RAIL TELEMATICS 9

Smart telematics enabling efficient rail transport-Single wagonload (SWL)- Communication technology in rail freight-on-line telematics data- Necessity and Applications- Roads and Railways

UNIT IV TELEMATIC DEVICES 9

Telematics devices- Telematics Information Portal and Data Distribution- Smartphone Data Collection- Self-Powered Data Collection- On-Board Diagnostics(OBD)- Black Box - OEM Embedded Data Collection and RodoTAG.

UNIT V TELEMATICS: BEST PRACTICES, REAL WORLD CHALLENGES 9

Intelligent Transport Systems - Vehicle to Vehicle and In-Vehicle Communication - Telematics Market forecast, Telematics usages in Automotives and Railways.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the Architecture of Telematics Systems and components	Understand
CO2: Describe the application of telematics in Rail Automation and Transport	Understand
CO3: Explain the Architecture and working of the Rail Telematics	Understand
CO4: Explain the construction and working of various telematics devices	Understand
CO5: Explain the various application and challenges in telematics	Understand

Text Book(s):

T1. Axel Fuchs, “Automotive Telematics: An Introduction to the Technical Aspects of Automotive With Reference to Business Model and User Needs”, Society of Automotive Engineers, 2002.

T2. V. Karevs, “Railway automation and telematics system's monitoring and diagnostic”, Lambert Publishing, 2019.

Reference Book(s):

R1. Development of Transport by Telematics, 19th International Conference on Transport System Telematics, TST 2019, Jaworze, Poland, Feb 27 - March 2, 2019.

R2. Dennis Foy, “Automotive Telematics: The One-stop Guide to In-vehicle Telematics and Infotainment Technology and Application” Red Hat Books, Pg 1-228, 2002.

Web Reference:

1. https://www.mobility.siemens.com/global/en/portfolio/rail/automation/telematic-systems.htm.
2. https://www.sciencedirect.com/science/article/pii/S2352146516303714.
3. https://www.researchgate.net/publication/234805517_A_telematics_approach_to_documentation_on_railways.
4. https://link.springer.com/book/10.1007/978-3-030-27547-1

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO2	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO3	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO4	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO5	2	1	-	-	-	-	-	2	2	3	-	2	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19MEOC1004</td><td colspan="3">Course Title: INDUSTRIAL AUTOMATION AND ROBOTICS</td></tr>
<tr><td colspan="3">Course Category: Open Elective</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Explain the basic concepts of Robots.
2. Describe different robotic components and its operations.
3. Explain various sensors and machine vision.
4. Apply different robot programming to actuate robots.
5. Explain the various industrial application of robots.

UNIT I INTRODUCTION 9

Definition of a Robot - Basic Concepts - Robot configurations - Types of Robot drive- Basic robot motions - Point to point control - Continuous path control.

UNIT II COMPONENTS AND OPERATION 9

Basic control system concepts - control system analysis - robot actuation and feedback, Manipulators – Forward and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of end effectors and interfaces.

UNIT III SENSING AND MACHINE VISION 9

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.

UNIT IV ROBOT PROGRAMMING 9

Methods - languages - Capabilities and limitation - Artificial intelligence - Knowledge representation - Search techniques – AI and Robotics.

UNIT V INDUSTRIAL APPLICATIONS 9

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the basic concepts of Robots used in various industries.	Understand
CO2: Describe different robotic components and its operations used in various industries.	Understand
CO3: Explain various sensors and machine vision used in various industrial robots.	Understand
CO4: Apply different robot programming to actuate robots for various industrial applications.	Understand
CO5: Explain the various industrial application of robots	Understand

Text Book(s):

T1. Mikell P. Groover, mitchell Weiss, “Industrial robotics, technology, Programming and Applications ", McGraw Hill International Editions, 2017.

T2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, " Robotic engineering - An Integrated Approach ", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

Reference(s):

R1. Er.R.K.Rajput, “Robotics and Industrial Automation” 3rd edition S Chand Publishers, 2008.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO2	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO3	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO4	2	1	-	-	-	-	-	2	1	2	-	1	2	-
CO5	2	1	-	-	-	-	-	2	1	2	-	1	2	-

High-3; Medium-2; Low-1

1.

Course Code:19MEOC1005	Course Title : VEHICULAR COMMUNICATION ELECTRONICS		
Course Category: Open Elective		**Course Level: Introductory**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Acquire knowledge on the construction and working Electronic Signal acquisition and conditioning devices
2. Acquire Design knowledge on a signal processing circuit using Operational amplifier for vehicular application
3. Acquire knowledge on the various types of coding methods used for signal transmission and reception used in vehicle systems
4. Acquire knowledge on the various types of modulation and demodulation technique used for signal transmission and reception used in vehicle communication
5. Acquire knowledge on the various types of transmission and reception medium and signals used in vehicle communication

UNIT I ELECTRONIC SIGNAL ACQUISITION AND CONDITIONING 9

Introductions to diodes- Laser diodes, Photo diodes, IR diodes construction, working-LEDs and Displays-Acoustic sensor -Amplifier: transistors, amplifier types-Power amplifiers

UNIT II SIGNAL PROCESSING USING OPERATIONAL AMPLIFIER 9

Introductions to operational amplifier-Inverting and Non-inverting modes-Signal operation on Op-Amp-signal filtering: High pass, low pass, Band pass, Band rejection

UNIT III SIGNAL CODING 9

Numbering systems, Signed magnitude, 2s Compliment, Fixed point, Floating points, Arithmetical operations-Parity-CRC-Gray codes-Binary coded decimals (BCD)-ASCII-

Analog , Digital signals - Serial in Serial out (SISO)- Parallel in parallel out (PIPO)- Parallel in Serial out (PISO)- Serial in parallel out (SIPO)

UNIT IV SIGNALS AND MODULATIONS 9

Analog to Digital conversion- Signal Band width and frequency- signal sampling- Nyquist theorem-Aliasing- phase- frequency-Modulation and Demodulation: Amplitude, Frequency, Phase - Digital Modulation: FSK, ASK, PSK

UNIT V COMMUNICATION MEDIUM 9

Guided medium-Twisted-pair wire, Coaxial cable, construction and characteristic - Fiber-optic cable, construction and characteristic. Unguided medium - Inferred -Microwave-RF- Antennas: Radiation, Gain, Polarization, Directionality, Antenna types and radiation patterns

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the construction and working Electronic Signal acquisition and conditioning devices used in Vehicle Communication	Understand
CO2: Design a signal processing circuit using Operational amplifier	Understand
CO3: Explain the various types of coding methods used for signal transmission and reception	Understand
CO4: Explain the various types of modulation and demodulation technique used for signal transmission and reception.	Understand
CO5: Describe the various types of transmission and reception medium and signals	Understand

Text Book(s):

T1. Roy Choudhury, Shail B. Jain, Linear Integrated Circuits, 2nd Edition, New Age International

T2. Boylestad, Robert L.. Electronic Devices and Circuit Theory, 2009. India: Pearson Education

T3. Madhow, Upamanyu. Introduction to Communication Systems. United Kingdom, Cambridge University Press, 2014.

Reference Book(s):

R1. Stanley, William D.. Operational Amplifiers with Linear Integrated Circuits. India, Pearson Education, 2002..

R2. Nashelsky, Louis, and Boylestad, Robert L.. Electronic Devices and Circuit Theory. N.p., Pearson Education, 2013.

R3. John G Proakis, Masoud Salehi, Fundamentals of Communication Systems. India, Pearson Education, 2007.

Web Reference:

1. https://nptel.ac.in/courses/117/103/117103063/
2. https://nptel.ac.in/courses/108/108/108108111/
3. https://nptel.ac.in/courses/108/104/108104091/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO2	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO3	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO4	2	1	-	-	-	-	-	2	2	3	-	2	-	-
CO5	2	1	-	-	-	-	-	2	2	3	-	2	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code:19MEOC1006</td><td colspan="3">Course Title : TOTAL QUALITY MANAGEMENT</td></tr>
<tr><td colspan="3">Course Category: Open Elective</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Explain the views of different quality gurus
2. Explain the principles and concepts inherent in a Total Quality Management (TQM) approach
3. Evaluate an industrial process
4. Explain the various quality tools for identifying appropriate process improvements
5. Explain the quality management

UNIT I INTRODUCTION 9

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II TQM PRINCIPLES 9

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure

UNIT III STATISTICAL PROCESS CONTROL (SPC) 9

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV TQM TOOLS 9

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, overview of FMEA – Stages of FMEA

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 and Other Quality Systems, ISO 9000:2004 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits - AS9100 – introduction.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the views of different quality gurus towards Total Quality Management.	Understand
CO2: Explain the principles and concepts inherent in a Total Quality Management (TQM) approach for managing a manufacturing or service organization	Understand
CO3: Evaluate an industrial process using control charts, process capability indices and six sigma.	Understand
CO4: Explain the various quality tools for identifying appropriate process improvements such as Bench marking, QFD,TPM and FMEA.	Understand
CO5: Explain the quality management with respect to the ISO 9000 & ISO 14000 quality management standards.	Understand

Text Book(s):

T1. Dale H. Besterfiled, et al., "Total Quality Management", Pearson Education, Inc. 2014.

T2. Subbarajramasamy, " Total Quality Management" McGraw-Hill, 2008.

Reference(s):

R1. James R.Evans& William M. Lidsay, "The Management and Control of Quality", 7th Ed., South-Western (Thomson Learning), 2009.

R2. Oakland.J.S. "Total Quality Management", Butterworth Hcinemann Ltd., Oxford, 2014.

Web References:

1. https://en.wikipedia.org/wiki/Total_quality_management

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO2	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO3	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO4	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO5	2	1	-	-	-	-	-	2	1	2	-	1	-	-

High-3; Medium-2; Low-1

Course Code:19MEOC1007	Course Title : INDUSTRIAL SAFETY ENGINEERING		
Course Category: Open Elective		Course Level: Introductory	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Explain the concepts of industrial safety.
2. Explain the concepts of accidents, accident record and reporting to real life problems.
3. Explain the evaluation of safety performance of an organization.
4. Explain the hazards and hazard assessment tools and methods.
5. Explain the role of Safety Management Systems.

UNIT I CONCEPT OF SAFETY **9**

Definition and measurement of risk, reliability and hazard potential, Elements of risk assessment – risk analysis techniques – risk reduction resources –Concepts of disaster control, job safety analysis, safety survey and safety inspection, Basic understanding of environmental, electrical, transport and nuclear safety, Safety in hazardous industries like chemical, mining and construction industry.

UNIT II ACCIDENT INVESTIGATION AND REPORTING **9**

Concept of an accident, unsafe act and condition, type of accidents: reportable and no reportable accidents, Principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, and concept of Zero Accident Potential (ZAP) and cost of accident.

UNIT-III MEASUREMENT OF SAFETY EFFICIENCY **9**

Safety audit methods, safety records management, Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, and safety "t" score, safety activity rate ,Safety audit, checklist analysis, what-if analysis, safety review, safety warning systems.

UNIT-IV HAZARDS AND HAZARD ASSESSMENT 9

Definition and types of Hazards, difference between Risk and Hazard, Hazard assessment, procedure, methodology; preliminary hazard analysis (PHA), human error analysis, hazard operability studies (HAZOP),Tools for Hazard Identification, Evaluating Hazards.

UNIT V SAFETY MANAGEMENT SYSTEMS: 9

Safety management systems in Indian industry, Engineering aspects of safety management, Safety legislations, implementation and monitoring of safety programs., Safety training, Introduction to OSHA, standards and guidelines, Personal Protective Equipment (PPE) - Requirements of PPE, Selection and Usage of PPE.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the concepts of industrial safety.	Understand
CO2. Explain the concepts of accidents, accident record and reporting to real life problems.	Understand
CO3. Explain the evaluation of safety performance of an organization.	Understand
CO4. Explain the hazards and hazard assessment tools and methods.	Understand
CO5. Explain the role of Safety Management Systems.	Understand

Text Book(s):

T1. Deshmukh.L.M "Industrial Safety Management" McGraw Hill Education, New edition,2017.

T2. C.RayAsfahl "Industrial Safety and Health management" Pearson Prentice Hall, 2003,

T3. Charles D. Reese "Occupational Health and Safety Management: A Practical Approach", Third Edition, CRC Press, 2017.

Reference(s):

R1. R.K. Jain And Prof. Sunil S. Rao, Industrial Safety, Health And Environment Management Systems, Khanna Publishers 4th ed. Edition, 2000.

R2. Krishnan N.V. “Safety Management in Industry” Jaico Publishing House, Bombay, 1997.

R3. Benjamin O. ALLI, Fundamental Principles of Occupational Health and Safety, Second Edition, ISBN -9221204545, International Labour Office, 2008.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO2	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO3	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO4	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO5	2	1	-	-	-	-	-	2	1	2	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEOC1008	Course Title: INDUSTRIAL ENGINEERING		
Course Category: Open Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the courses:

- Nil

Course Objectives

The course is intended to:

1. Explain the concept of industrial engineering
2. Explain appropriate work and method study
3. Identify the suitable forecasting techniques
4. Explain the concept of ergonomics
5. Explain the importance of property rights and Industrial legislation

UNIT I INTRODUCTION 10

INDUSTRIAL ENGINEERING: Meaning, Definition, Objective, Need, Scope, Evolution and developments. Concept of quality and cost, Logistics, Production planning and inventory control, Quality control PRODUCTIVITY: Definition of productivity, task of management Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs, wages and incentives (simple numerical problems). PRODUCT DESIGN AND DEVELOPMENT: Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering.

UNIT II WORK AND METHOD STUDY 10

WORK STUDY: Definition, objective and scope of work study. Human factors in work study. Work study and management, work study and supervision, work study and worker. Taylor’s scientific management, Gilbreths’s contributions; productivity – concepts and measurements METHOD STUDY: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts. principles of motion economy; work measurement – stop watch time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering.

UNIT III PRODUCTION PLANNING AND INVENTORY CONTROL 9

Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; order control and flow control; routing, scheduling and priority dispatching; push and pull production systems, concept of JIT manufacturing system; logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems..

UNIT IV ERGONOMICS 9

Introduction, areas of study under ergonomics, system approach to ergonomics model, man-machine system. Components of man-machine system and their functions – work capabilities of industrial worker, study of development of stress in human body and their consequences. Computer based ergonomics. DESIGN OF MAN-MACHINE SYSTEM: Fatigue in industrial workers, Quantitative qualitative representation and alphanumeric displays, Controls and their design criteria, control types, relation between controls and displays, layouts of panels and machines. Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light.

UNIT V PROPERTY RIGHTS AND INDUSTRIAL LEGISLATION 7

Definition of intellectual property, importance of IPR; TRIPS and its implications, patent, copyright, industrial design and trademark. Need for Industrial legislation, Factories act 1948, Industrial dispute act 1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952 – Group Discussion.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain concept of industrial Engineering to take the right decisions to optimize resources utilization by improving productivity	Understand
CO2: Explain the work study to eliminate unproductive activities and method study to use the Charts to record the Activities of the people, materials and Equipment for minimizing the waste and implement the best method.	Understand
CO3: Identify the suitable forecasting techniques to improve the processes and find the Standard Time for given applications	Understand
CO4: Explain the concept of ergonomics to design the Man – Machine System to improve Human Efficiency and reduce the effort of the workers for a given resources	Understand
CO5: Explain the importance of property rights and Industrial legislation for the betterment of employees	Understand

Text Book(s):

T1. Khan, M.I, “Industrial Engineering”, New Age International, 2nd Edition, 2009.

T2. “Work study”, ILO, Second Edition, Oxford and IBH Publishin, 2010.

T3. Kapoor N.D, “Handbook of Industrial Law”, sultan Chand & sons, 14th revised edition 2013.

Reference Book(s):

R1. “Human Factors in Engineering Design” - S Sanders and E J McCormick, 7th Edition, 2016.

R2. Industrial Engineering and Production management”, Martand Telsang, S. Chand Publisher, 2006.

R3. Paul Kales, “ Reliability for Technology Engineering and Management”, Prentice Hall, New Jersey, 1998.

Web References:

1. http://www.nptel.ac.in/courses/112106175/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO2	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO3	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO4	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO5	2	1	-	-	-	-	-	2	1	2	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19MEOC1009	**Course Title: RENEWABLE SOURCES OF ENERGY**		
Course Category: Open Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Discuss the importance and Economics of renewable Energy
2. Discuss the method of power generation from Solar Energy
3. Discuss the method of power generation from Wind Energy
4. Explain the method of power generation from Bio Energy
5. Explain the Tidal energy, Wave Energy, OTEC, Hydro energy, Geothermal Energy, Fuel Cells and Hybrid Systems.

UNIT I INTRODUCTION 9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamil nadu, India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems.

UNIT II SOLAR ENERGY 9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT III WIND ENERGY 9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection– Details of Wind Turbine Generator – Safety and Environmental Aspects

UNIT IV BIO ENERGY 9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Discuss the importance and Economics of renewable Energy	Understand
CO2: Discuss the method of power generation from Solar Energy	Understand
CO3: Discuss the method of power generation from Wind Energy	Understand
CO4: Explain the method of power generation from Bio Energy	Understand
CO5: Explain the Tidal energy, Wave Energy, OTEC, Hydro energy, Geothermal Energy, Fuel.	Understand

Text Book(s):

T1. Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.

T2. Twidell, J.W. &Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.

Reference(s):

R1. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.

R2. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2017.

R3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.

Web References:

1. http://www.icebookshop.com
2. http://nptel.ac.in/courses/112107143/40

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO2	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO3	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO4	2	1	-	-	-	-	-	2	1	2	-	1	-	-
CO5	2	1	-	-	-	-	-	2	1	2	-	1	-	-

High-3; Medium-2; Low-1