KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

B.E., MECHANICAL ENGINEERING

REGULATIONS 2018

CURRICULUM AND SYLLABI

Batch 2021 onwards

Department of Mechanical Engineering

C. Velmurugan

Approved by BoS Chairman

VISION

To emerge as a center that imparts quality higher education through its program in the domain of Mechanical Engineering to meet the changing needs of the society.

MISSION

1. To promote innovation in the Mechanical Engineering through curriculum, focusing on sustainability and ethical practices.
2. To create an active learning ecosystem for acquiring knowledge and skills in Mechanical Engineering.
3. To facilitate research in mechanical systems and sustainable technologies that have an impact on industry and society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Mechanical Engineering Undergraduate Program are to prepare the students:

I. Graduates will take up careers in manufacturing and design related sectors.

II. Graduates will be involved in the execution of mechanical engineering projects.

III. Graduates will take up educational programmes in mastering Mechanical Engineering Science and Management.

PROGRAM OUTCOMES (POs)

Graduates of the Mechanical Engineering Undergraduate Program should have the ability to:

PO 1: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of the Mechanical Engineering Undergraduate Program will have the ability to:

PSO 1: Apply the fundamentals of science and mathematics to solve complex problems in the field of design and thermal sciences.

PSO 2: Apply the concepts of production planning and industrial engineering techniques in the field of manufacturing engineering.

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KUMARAGURU COLLEGE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
B.E MECHANICAL – Curriculum (Regulation 2018)
Batch 2021 onwards

Semester III										
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	**Pre-requisite**
1	U18MAT3101	Partial differential equations and transforms	Theory	BS	3	1	0	0	4	--
2	U18MEI3201	Metal Cutting and Computer Aided Manufacturing	Embedded-Theory & Lab	PC	3	0	2	0	4	--
3	U18MET3002	Engineering Mechanics	Theory	ES	3	0	0	0	3	--
4	U18MET3003	Engineering Thermodynamics	Theory	PC	3	0	0	0	3	--
5	U18MET3004	Computer aided design	Theory	ES	3	0	0	0	3	--
6	U18MET3005	Machine drawing	Theory	PC	2	0	0	0	2	--
7	U18MEP3006	Machine drawing Laboratory	Practical	PC	0	0	2	0	1	--
8	U18INI3600	Engineering Clinic III	Project based course	ES	0	0	4	2	3	--
								Total Credits	**23**	

Semester IV										
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	**Pre-requisite**
1	U18MAT4101	Numerical Methods and Probability	Theory	BS	3	1	0	0	4	--
2	U18MEI4201	Strength of Materials	Embedded - Theory & Lab	PC	3	0	2	0	4	U18MET3002
3	U18MEI4202	Fluid Mechanics and Machinery	Embedded - Theory & Lab	PC	3	0	2	0	4	--
4	U18MET4003	Kinematics of Machinery	Theory	PC	3	0	0	0	3	U18MET3002
5	U18INI4600	Engineering Clinic IV	Project based course	ES	0	0	4	2	3	U18INI3600
6	U18CHT4000	Environmental Science and Engineering	Theory	MC	3	0	0	0	0	--
7	U18EEI4207	Electrical Drives and Control	Embedded - Theory & Lab	ES	3	0	2	0	4	--
8	U18MEP4704	Industrial Internship	Project based course	PW	0	0	0	2	0	--
9	U18VET4101	Universal Human Values 2: Understanding Harmony	Theory	HS	2	1	0	0	3	--
								Total Credits	**25**	

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Semester V										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18MEI5201	Thermal Engineering	Embedded - Theory & Lab	PC	3	0	2	0	4	U18MET3004
2	U18MEI5202	Engineering Metrology and Quality Control	Embedded - Theory & Lab	PC	3	0	2	0	4	Nil
3	U18MET5003	Design of Machine Elements	Theory	PC	3	0	0	0	3	U18MEI4201
4	U18MET5004	Turbo Machines	Theory	PC	3	0	0	0	3	Nil
5	U18MEI5205	Dynamics of Machinery	Embedded- Theory & Lab	PC	3	0	2	0	4	U18MET4003
6	U18-------	Open Elective - I	Theory	OE	3	0	0	0	3	Nil
7	U18MEE---	Programme Elective I	Theory	PE	3	0	0	0	3	U18INI4600
Total Credits									24	

Semester VI										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18MEI6201	Heat and Mass Transfer	Embedded - Theory & Lab	PC	3	0	2	0	4	Nil
2	U18MET6002	Operations Research	Theory	PC	3	0	0	0	3	Nil
3	U18MEI6203	Finite Element Analysis	Embedded Theory & Lab	PC	3	0	2	0	4	Nil
4	U18-------	Open Elective - II	Theory	OE	3	0	0	0	3	Nil
5	U18MEE----	Programme Elective II	Theory	PE	3	0	0	0	3	Nil
6	U18MET6004	Design of Transmission system	Theory	PE	3	0	0	0	3	U18MET5003
7	U18MEP6006	Technical seminar and Publication	Project Based Course	ES	0	0	0	2	1	Nil
8	U18MET6005	Applied Materials Engineering	Theory	PC	3	0	0	0	3	Nil
9	U18INI6000	Constitution of India	Theory	HS	3	0	0	0	0	Nil
Total Credits									24	

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Semester VII										
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	**Pre-requisite**
1	U18MET7001	Engineering Economics and Financial Management	Theory	HS	3	0	0	0	3	Nil
2	U18MET7002	Power Plant Engineering	Theory	PC	3	0	0	0	3	Nil
3	U18MEE----	Programme Elective III	Theory	PE	3	0	0	0	3	Nil
4	U18MET7003	Digital Manufacturing	Theory	PC	3	0	0	0	3	Nil
5	U18MEP7703	Mini Project/ Phase I Project	Project only Course	PW	0	0	0	4	3	Nil
								Total Credits	15	

Semester VIII									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
1	U18MET8001	Entrepreneurship Development	Theory	EEC	3	0	0	0	3
2	U18MEE----	Programme Elective IV	Theory	PE	3	0	0	0	3
3	U18MEP8702	Capstone Project/Internship/Phase II project	Project only Course	PW	0	0	0	24	10
								Total Credits	16
								Total Credits	169

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Programme Electives									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
Design Engineering									
1	U18MEE0001	Design of Jigs, Fixtures and Press Tools	Theory	PE	3	0	0	0	3
2	U18MEE0002	Vibration and Noise Control	Theory	PE	3	0	0	0	3
3	U18MEE0003	Composite Materials	Theory	PE	3	0	0	0	3
4	U18MEE0004	Design for Manufacturing and Environment	Theory	PE	3	0	0	0	3
5	U18MEE0005	Tribology	Theory	PE	3	0	0	0	3
6	U18MEE0020	Reverse Engineering	Theory	PE	3	0	0	0	3
7	U18MEE0021	Design for Sustainability	Theory	PE	3	0	0	0	3
8	U18MEE0022	Advanced Strength of Materials	Theory	PE	3	0	0	0	3
9	U18MEE0023	Design Thinking	Theory	PE	3	0	0	0	3
10	U18MEE0024	Product Design and Development	Theory	PE	3	0	0	0	3
11	U18MEE0025	Product Lifecycle Management	Embedded Theory & Lab	PE	2	0	2	0	3
Thermal Engineering									
1	U18MEE0006	Refrigeration and Air Conditioning	Theory	PE	3	0	0	0	3
2	U18MEE0007	Computational Fluid Dynamics	Theory	PE	3	0	0	0	3
3	U18MEE0008	Design of Thermal Systems	Theory	PE	3	0	0	0	3
4	U18MEE0009	Design of Heat Exchangers	Theory	PE	3	0	0	0	3
5	U18MEE0010	Gas dynamics and jet propulsion	Theory	PE	3	0	0	0	3
6	U18MEE0011	Automobile Engineering	Theory	PE	3	0	0	0	3
7	U18MEE0026	Solar Energy Engineering	Theory	PE	3	0	0	0	3
8	U18MEE0027	Renewable Energy Sources	Theory	PE	3	0	0	0	3
9	U18MEE0028	Introduction to Oil and Gas Engineering	Theory	PE	3	0	0	0	3
Manufacturing Engineering									
1	U18MEE0012	Additive Manufacturing	Theory	PE	3	0	0	0	3
2	U18MEE0013	Modern Machining Processes	Theory	PE	3	0	0	0	3
3	U18MEE0014	Welding and Allied Processes	Theory	PE	3	0	0	0	3
4	U18MEE0015	Lean Manufacturing	Theory	PE	3	0	0	0	3
5	U18MEE0029	Theory and Practice of Non-Destructive Testing	Embedded Theory & Lab	PE	2	0	2	0	3
6	U18MEE0030	Green Manufacturing: Conceptual Design and Its Practices	Theory	PE	3	0	0	0	3
Industrial Engineering									
1	U18MEE0016	Plant Layout and Process Design	Theory	PE	3	0	0	0	3
2	U18MEE0017	Logistics and Supply Chain Networks	Theory	PE	3	0	0	0	3

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3	U18MEE0018	Industrial Safety	Theory	PE	3	0	0	0	3
4	U18MEE0019	Industrial Marketing	Theory	PE	3	0	0	0	3
Electives from Emerging Areas									
1	U18MEE0031	Problem Solving Using Python	Embedded Theory & Lab	PE	2	0	2	0	3
2	U18MEE0032	Data Science	Theory	PE	3	0	0	0	3

One Credit Courses									
1.	U18MEC0001	Smart Manufacturing	Theory	PE	1	0	0	0	1
2.	U18MEC0002	Nano Technology: Mechanical Engineering's New Frontier	Theory	PE	1	0	0	0	1
3.	U18MEC0503	ANSYS Multiphysics	Practical Course	PE	0	0	2	0	1
4.	U18MEC0004	Renewable Energy Sources	Theory	PE	1	0	0	0	1
5.	U18MEC0205	Advanced Heat Transfer Enhancement	Theory	PE	1	0	0	0	1
6.	U18MEC0006	Industrial Robotics	Theory	PE	1	0	0	0	1

Nano Program in
New Product Development (NPD) and Product Life Cycle Management (PLM)
Optional Elective Courses with credits and Non CGPA

S.No	Course code	Course Title	Sem.	Course Mode	L	T	P	J	C
1	U18MEE0033	Product Design and Manufacturing	4	Theory & Practical	2	0	2	0	3
2	U18MEE0034	Product Data and Product Lifecycle Management	5	Theory & Practical	2	0	2	0	3
3	U18MEP6703	Project Work	6	Project	0	0	0	4	3
4	U18MEP7704	Internship and Documentation	7	Practical	0	0	0	2	0
Total = 9 Credits									

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III Semester

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U18MAT3101	**PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS**	**L**	**T**	**P**	**J**	**C**
		3	**1**	**0**	**0**	**4**

(Common to AE/AUE/CE/ME/MCE/EEE)

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Formpartialdifferentialequationsandsolvecertaintypesofpartialdifferential equations.

CO 2 Determine the Fourier Series and half range Fourier Series of a function.

CO 3 Solve one dimensional wave equation, one dimensional heat equation in steady state using Fourier series.

CO 4 Apply Fourier series to solve the steady state two-dimensional heat equation in cartesian coordinates.

CO 5 Identify Fourier transform, Fourier sine and cosine transform of certain functions and use Parseval's identity to evaluate integrals.

CO 6 Evaluate Z–transform of sequences and inverse Z–transform of functions and solve difference equations.

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M			M				M	M		S		
CO2	S	M		M										
CO3	S	S	S		S				M	M		S		
CO4	S	M	M									M		
CO5	S	M	M		S									
CO6	S	S			S				M	M		S		

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

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PARTIAL DIFFERENTIAL EQUATIONS **9+3 Hours**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of PDE by variable separable method – Solution of standard types of first order partial differential equations (excluding reducible to standard types) – Lagrange's linear equation – Linear homogeneous partial differential equations of second and higher order with constant coefficients.

FOURIER SERIES **9+3 Hours**

Dirichlet's conditions – General Fourier series – Odd and Even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.

BOUNDARY VALUE PROBLEMS – ONE DIMENSIONAL EQUATIONS **5+2 Hours**

Classification of second order quasi linear partial differential equations –Solution of one-dimensional wave equation – One dimensional heat equation (excluding insulated ends), Fourier series solutions in Cartesian coordinates.

BOUNDARY VALUE PROBLEMS – TWO DIMENSIONAL EQUATIONS **4+1 Hours**

Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

FOURIER TRANSFORM **9+3 Hours**

Statement of Fourier integral theorem – Infinite Fourier transforms – Sine and Cosine Transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

Z –TRANSFORM **9+3 Hours**

Z-transform - Elementary properties – Convolution theorem- Inverse Z – transform
(by using partial fractions, residues and convolution theorem) – Solution of difference equations using Z - transform.

Theory: 45 **Tutorial: 15** **Practical: 30** **Project: 0** **Total: 60 hours**

References:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition. 2014.
2. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
3. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics Volume III", S.Chand& Company ltd., New Delhi, 2006.
4. Ian Sneddon., "Elements of partial differential equations", McGraw – Hill, New Delhi, 2003.
5. Arunachalam T., "Engineering Mathematics III", Sri Vignesh Publications, Coimbatore 2013.

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U18MEI3201 METAL CUTTING AND COMPUTERAIDED MANUFACTURING

L	T	P	J	C
3	0	2	0	4

Course outcomes

After successful completion of the course, the student would be able to

CO 1 Apply the fundamentals of metal cutting and cutting tool materials

CO 2 Study the types of machine tools and working principles of machine tools

CO 3 Apply principles of surface integrity in finishing processes and study gear manufacturing techniques

CO 4 Apply the manufacturing activities inter relation with computers for plant operations

CO 5 Apply the concept of Group Technology in computer aided manufacturing

CO 6 Apply system modeling tools in CIM and the fundamental concepts of data communications

Pre-requisite: Nil

CO / PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	S							S	S				S
CO2	M								S	S				S
CO3	S								S	S				S
CO4	M						M							S
CO5	M						M		M	M				S
CO6	M				M		M		M	M				S

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory component) 2. Assignment; Group Presentation, Project 3. Demonstration etc (as applicable) (Theory component) 4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component) 5. Model Examination (lab component) 6. End Semester Examination (Theory and lab components)
INDIRECT
1. Course-end survey

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THEORY OF METAL CUTTING **9 Hours**

Introduction to Metal Cutting Methods – Mechanics of Metal Cutting – Orthogonal – Oblique – Merchants' Circle Diagram – Details of Derivation – Chip Details – Heat Generation – Cutting Tool Life – Cutting Tool Nomenclature – Economics of tool life – Optimal cutting speed for productivity - Cutting tool Materials - Cutting fluids – Recent Developments and Applications - Dry Machining and High-Speed Machining

MACHINE TOOLS **8 Hours**

Introduction to Lathe – Shaper – Planning – Milling – Drilling – Boring – Grinding – Honing – Working Principles – Operations – Working Holding Devices.

SURFACE FINISHING PROCESSES AND GEAR MANUFACTURING **8 Hours**

Grinding Machines – Grinding wheel Specifications – Honing – Lapping –Burnishing – Super Finishing – Surface Integrity concepts – Gear Manufacturing Processes – Gear cutting – Gear Hobbing – Gear Shaping Machines – Manufacture of Spur – Helical – Bevel – Worm and Worm Wheel – Gear Finishing, Honing.

INTRODUCTION TO NUMERICAL CONTROL **7 Hours**

Introduction, programmed automation, Nomenclature, type and features of NC machine tools, Axes designation, point to point, straight and continuous control systems

INTRODUCTION TO COMPUTER INTEGRATED MANUFACTURING **7 Hours**

The meaning and origin of CIM- the changing manufacturing and management scene - External communication - islands of automation and software-dedicated and open systems- product related activities of a company- marketing engineering - production planning - plant operations - physical distribution- business and financial management.

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING **7 Hours**

Role of Group Technology in CAD/CAM integration - part families - classification and coding - DCLASS, MICLASS and OPITZ coding systems-benefits of Group Technology Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning -variant approach and generative approaches.

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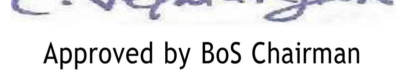
INTEGRATED LAB EXPERIMENTS:

1. Spur Gear cutting using Milling machine
2. Dove tail machining using shaper machine
3. Cylindrical grinding and Surface grinding on given workpiece
4. Facing, plain and step turning and taper turning.
5. Single start V-Thread cutting and knurling.
6. Boring and internal thread cutting.
7. Manual part programming (using G and M codes) in CNC Lathe. Machining operations include turning, facing, taper turning, and step turning (any two operations).
8. Machining operations include Linear and Circular interpolation, chamfering and grooving (any two operations).
9. Manual part programming (using G and M codes) in CNC Milling. Machining operations include Linear and Circular interpolation (contour motions).

Theory: 45 Tutorial: 0 Practical: 30 Project: 0 Total: 75 hours

REFERENCES:

1. Jain, R.K., and Gupta, S.C., "Production Technology", Khanna Publishers, New Delhi, 2004.
2. Sharma P.C., "A Text Book of Production Technology", S.Chand& Company Ltd., New Delhi,2010.
3. HajraChoudhry, S.K., and Bose, S.K., "Workshop Technology", Media Promoters and Publishers Pvt. Ltd., Bombay, 2004.
4. Mikell.P.Groover,"Automation, Production Systems and computer integrated manufacturing", Pearson Education,2007.
5. Radhakrishnan P, SubramanyanSandRaju V., "CAD/CAM/CIM",New Age International (P) Ltd, New Delhi, 2004.
6. Ranky, Paul G.,"Computer Integrated Manufacturing", Prentice Hall International, 2003.
7. David D.Bedworth, Mark R.Hendersan, Phillip M.Wolfe "Computer Integrated Design and Manufacturing", McGraw-Hill Inc, 2004.



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U18MET3002 **ENGINEERING MECHANICS**

L	T	P	J	C
3	0	0	0	3

CO 1 Apply the fundamental concepts in determining the effect of forces on a particle.

CO 2 Make use of various principles in the determination of effect of forces in a rigid body.

CO 3 Determine the geometry dependent properties of solids and sections

CO 4 Solve problems in static friction

CO 5 Identify motion and determine the velocity and acceleration of a particle

CO 6 Apply the principles of kinetics in solving problems in dynamics

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						M	
CO2	S						W						M	
CO3	S						W						M	
CO4	M						W						M	
CO5	M						W						M	
CO6	M						W						M	

Course Assessment methods:

DIRECT

1. Continuous Assessment Test I, II (Theory component)
2. Assignment; Group Presentation, Project
3. Demonstration etc (as applicable) (Theory component)
4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)
5. Model Examination (lab component)
6. End Semester Examination (Theory and lab components)

INDIRECT

1. Course-end survey

STATICS OF PARTICLES **9 hours**

Introduction - Laws of Mechanics, Parallelogram and triangular Laws of forces – Coplanar Forces - Resolution and Composition of forces – Free body diagram - Equilibrium of a particle– Lami's theorem – Equilibrium of a particle in space.

STATICS OF RIGID BODIES **9 hours**

Principle of transmissibility – Moment of force about a point – Varignon's theorem – Moment of a couple – Equivalent couple – Moment of force about an

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axis – Coplanar non-concurrent forces acting on rigid bodies – Resultant and equilibrium – Resolution of a given force into force couple system – Equilibrium in three dimensions – Reactions and supports.

GEOMETRY DEPENDENT PROPERTIES **9 hours**

Centre of gravity, Centre of mass and Centroid – Moment of Inertia of simple and complex areas – Transfer formula – Radius of gyration – Polar moment of inertia – Product of inertia - Mass moment of Inertia of simple solids.

FRICTION **9 hours**

Laws of friction – coefficient of friction – Dry friction – wedge friction – ladder friction – rolling resistance.

KINEMATICS OF PARTICLES **3 hours**

Kinematics – Rectilinear and curvilinear motion – projectile motion

KINETICS OF PARTICLES **6 hours**

Kinetics – Newton's law – D'Alembert's Principle – Work Energy method – Principle of Impulse momentum - Impact

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 hours**

REFERENCES:

1. Beer F P and Johnson E R, "Vector Mechanics for Engineers, Statics and Dynamics", Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi, 2006.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013. 2. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics (Volume II), 7th edition, Wiley student edition, 2013.
3. P. Boresi& J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008. Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.
4. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi, 2006

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U18MET3003 ENGINEERING THERMODYNAMICS

L	T	P	J	C
3	0	0	0	3

(Use of standard Steam table and Mollier diagram, Psychrometric Chart and Gas Tables are permitted)

Course outcomes

After successful completion of the course, the student would be able to

CO 1 Illustrate basic concepts for solving problems in open and closed system.

CO 2 Apply second law concepts to heat engine and heat pumps.

CO 3 Apply concepts of entropy

CO 4 Compare the performance of various vapor power cycles

CO 5 Illustrate the significance of thermodynamics relations

CO 6 Solve problems in various psychrometric processes

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	M								S	M		W	M	
CO2	S	W							S	S		M	M	
CO3	S	W							M	M			M	
CO4	S	M							S	S		W	S	
CO5	M									S			M	
CO6	M								M	M			M	

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory component) 2. Assignment; Group Presentation, Project 3. Demonstration etc (as applicable) (Theory component) 4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component) 5. Model Examination (lab component) 6. End Semester Examination (Theory and lab components)
INDIRECT
1. Course-end survey

BASIC CONCEPTS AND FIRST LAW **12 hours**

Basic concepts - concept of continuum, macroscopic approach: thermodynamic systems - closed,

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open and isolated: Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics – concept of temperature and heat. Concept of ideal and real gases. First law of thermodynamics – SFEE - Application to closed and open systems

SECOND LAW AND ENTROPY **12 hours**

Second law of thermodynamics – Kelvin's and Clausius statements of second law, Heat Engines, Refrigerator and Heat Pump, Coefficient of Performance, Reversibility Carnot cycle - reversed Carnot cycle, efficiency, Carnot theorem, Thermodynamic temperature scale. Clausius theorem, Clausius inequality, concept of entropy, entropy of ideal gas, change of entropy for different non-flow processes, principle of increase of entropy – absolute entropy, Availability and irreversibility

STEAM AND VAPOUR CYCLES **10 hours**

Formation of steam at constant pressure, types of steam, steam tables and uses, external work done during evaporation, internal energy of Steam, dryness fraction of steam, entropy of steam – Mollier diagram steam power cycles, standard Rankine cycle, modified Rankine cycle. Reheat and regenerative cycle, Air standard otto cycle, Process making of the cycle, Cycle thermal efficiency, Compression expansion ratio and cycle efficiency, Deviation of real spark ignition engine from ideal cycle engines.

IDEAL AND REAL GASES AND THERMODYNAMIC RELATIONS **7 hours**

Properties ideal and real gases, equation state, Vander Wall's equation of state, compressibility factor, compressibility chart- Dalton's law of partial pressure, exact differentials, T-D relations, Maxwell's relations, Clausius Clapeyron equations, Joule-Thomson coefficient.

PSYCHROMETRY **4 hours**

Avagadro's Law, equation state, Gas mixtures, Dalton's law, Psychrometry and psychrometric charts, property calculations of air vapor mixtures.

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 hours**

REFERENCES:

1. Nag, P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2008.
2. Cengel Y., "Thermodynamics An Engineering Approach", Tata McGraw-Hill, NewDelhi, 2008.
3. Holman.J.P. "Thermodynamics", Tata MC Graw Hill, 2006.
4. Arora, C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2004.
5. Merala, C. Pother, Craig, W., Somerton, "Thermodynamics for Engineers", Schaum Outline Series, McGraw-Hill, 2008.
6. Rogers and Mayhew, "Engineering Thermodynamics", Work and Heat Transfer, Pearson education, 1992.

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U18MET3004	COMPUTER AIDED DESIGN	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (COs)

After successful completion of the course, the students should be able to

CO 1 Apply the concepts of computer graphics and graphics systems.

CO 2 Apply transformations and graphics pipeline procedure.

CO 3 Apply the concepts of various types of curves and surfaces.

CO 4 Practice the solid modeling features.

CO 5 Apply various Graphic file standards with their importance.

CO 6 Apply Interactive Computer Programming techniques.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			M		S									
CO2		M												
CO3	M		M										M	
CO4					S								M	
CO5					M									
CO6					M									

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory component) 2. Assignment; 3. Demonstration etc (as applicable) (Theory component) 4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component) 5. Model Examination (lab component) 6. End Semester Examination (Theory and lab components)
INDIRECT
1. Course-end survey

FUNDAMENTALS OF COMPUTER GRAPHICS **9 hours**

Product cycle- Design process- sequential and concurrent engineering- Computer aided design —CAD system architecture- Computer graphics — co-ordinate systems- 2D and 3D transformations-homogeneous coordinates - Line drawing -Clipping- viewing transformation

GEOMETRIC MODELING **9 hours**

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-

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Techniques for surface modeling — surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep

VISUAL REALISM **9 hours**

Hidden — Line-Surface-Solid removal algorithms — shading — colouring — computer animation.

ASSEMBLY OF PARTS **9 hours**

Assembly modelling — interferences of positions and orientation — tolerance analysis-massproperty calculations — mechanism simulation and interference checking.

CAD STANDARDS **9 hours**

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images-Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. -communication standards.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

REFERENCES:

1. Donald Hearn and Pauline Baker, "Computer Graphics C Version", Pearson Education, 2004.
2. Michael E Mortenson, "Geometric Modeling", John Wiley and Sons, Inc., 2004.
3. David F Rogers and Alan Adams J, "Mathematical Elements in Computer Graphics", Tata McGraw Hill, 2002.
4. James D Foley, Andries Van Dam, Steven K Feiner and John F Hughes, "Computer Graphics Principles and Practice", Addison Wesley Publishing Company, 2000.
5. Martti Mantyla, "An Introduction to Solid Modeling", Springer Verlag, 1987.

U18MET3005 **MACHINE DRAWING**

L	T	P	J	C
2	0	0	0	2

Course Outcomes (COs)

After successful completion of the course, the students should be able to

CO 1 Recall standard drawing notations from memory

CO 2 Demonstrate the understanding of the basic concepts of Machine drawing

CO 3 Apply the principles of drawing while preparing component and assembly drawings.

CO 4 Analyze the concepts of drawings and select the appropriate one to be used

CO 5 Evaluate the correctness of the drawing based on a set of criteria and making technical comments

CO 6 Create drawings by a combination of drawing principles

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S									M				M
CO2	S									S				M
CO3	S	M		M	M				S	S			M	M
CO4	S	S		S					S	S		S	M	M
CO5	S	S		S	S	S		S	S	S			M	M
CO6	S	S		S	S	S		S	S	S		S	M	M

Course Assessment methods:

DIRECT
1. **Assignments** 2. **Continuous Assessment Test I, II** 3. **End Semester Examination**
INDIRECT
1. Course-end survey

BASICS OF MACHINE DRAWING **5 hours**

BIS Code of Engineering Drawing, Abbreviations and Conventional representation of standard components, Dimensioning systems and types, Sectioning conventions, surface finish symbols, Representation of welding joints, reverted joints, and screw threads.

FITS AND TOLERANCES **5 hours**

Types of fits – types of tolerance – representation of tolerance on drawing – Hole and shaft basis system, Geometrical tolerance – form and position tolerances – symbols – indicating geometrical tolerances on drawings – Introduction

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to selective assembly and interchangeable manufacture.

ASSEMBLY DRAWING **20 hours**

Fasteners – square threaded nut and bolt – Hexagonal headed nut and bolt

Unprotected type flange coupling

Cotter joint with sleeve, Jib & cotter joint

Footstep journal bearing, Screw jack, Plummer block

TOTAL: 30 hours

REFERENCES:

1. Gopalakrishna K.R., Machine Drawing, 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013
2. S. Bogolyubov. A. Voinov., ―Engineering Drawing, Van Nostrand Reinhold Company, 2001.
3. D. E. Hewitt., ―Engineering Drawing and Design for Mechanical Technicians, The Macmillan Press Ltd, London, 2006.
4. Brain Griffiths., Engineering Drawing for Manufacture, Kogan Page Science, USA, 2003.

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U18MEP3006 **MACHINE DRAWING LABORATORY**

L	T	P	J	C
0	0	2	0	1

Course Outcomes (COs)

After successful completion of the course, the students should be able to

CO 1 Prepare drawings depicting interpenetration of simple solids and auxiliary views of machine parts

CO 2 Develop 3D models of machine parts using various CAD software's

CO 3 Develop 3D Assembly of machine components using CAD soft ware's

CO 4 Prepare assembly drawings from detailed drawings of machine subassemblies.

CO 5 Convert 3D models to 2D drawings using various CAD software's.

CO 6 Able to convert actual physical measurement of component dimensions into 3D models.

Pre-requisite: Nil

CO / PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S									M				M
CO2	S									S				M
CO3	S								S	S			M	M
CO4	S								S	S		S	M	M
CO5	S							S	S	S			M	M
CO6	S							S	S	S		S	M	M

Course Assessment methods:

DIRECT
1. Lab Assignments **2. Model Examinations** **3. End Semester Practical Examination**
INDIRECT
1. Course-end survey

LIST OF EXPERIMENTS: **30 hours**

Drawing of Parts and assembly drawings of

1. Fasteners (Square and Hexagonal headed bolt and nut)
2. Flange coupling (Unprotected),
3. Footstep Journal Bearing
4. Screw Jack
5. Plummer block.
6. Gib and cotter joint
7. Cotter joint with sleeve

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L	T	P	J	C
0	0	4	2	3

U18INI3600 ENGINEERING CLINIC - III

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify a practical problem and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite: **Nil**

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct	**Indirect**
1. Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the Third semester, students will focus primarily on Design project combining concepts learnt in Engineering clinics I and II.

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific task, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

IV Semester

C. Velmurugan

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L	T	P	J	C
3	1	0	0	4

U18MAT4101 NUMERICAL METHODS AND PROBABILITY

(Common to AE/AUE/CE/ME/MCE/EEE)

COURSE OUTCOMES
After successful completion of this course, the students will be able to

CO1: Apply various numerical techniques for solving non-linear equations and systems of linear equations.
CO2: Analyze and apply the knowledge of interpolation and determine the integration and differentiation of the functions by using the numerical data.
CO3: Predict the dynamic behavior of the system through solution of ordinary differential equations by using numerical methods.
CO4: Solve PDE models representing spatial and temporal variations in physical systems through numerical methods
CO5: Apply the concepts of probability to random variables
CO6: Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	S												
CO2	S	S												
CO3	S	S							M					
CO4	S	S												
CO5	S	S							M					
CO6	S	S												

COURSE ASSESSMENT METHODS

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-end survey

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SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS **9+3 Hours**

Linear interpolation method – Iteration method – Newton's method – Solution of linear system by Gaussian elimination and Gauss-Jordan methods - Iterative methods: Gauss Jacobi and Gauss - Seidel methods – Inverse of matrix by Gauss – Jordan method – Eigenvalues of a matrix by Power method.

INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION **9+3 Hours**

Lagrange's and Newton's divided difference interpolation – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal and Simpson's rules.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS **9+3 Hours**

Single step methods: Taylor's series method – Euler and Improved Euler methods for solving a first order equations – Fourth order Runge-Kutta method for solving first and second order equations – Multistep method: Milne's predictor and corrector method.

BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS **9+3 Hours**

Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain–Solution of one-dimensional heat equation using Bender Schmidt and Crank Nicholson difference schemes –Solution of one dimensional wave equation by explicit scheme.

PROBABILITY AND RANDOM VARIABLES **9+3 Hours**

Axioms of probability - Conditional probability – Total probability – Bayes' theorem – Random variable – Distribution function – properties – Probability mass function- Probability density function – moments - Binomial, Poisson and Normal distributions – Properties.

Theory: 45 Hours **Tutorials: 15 Hours** **Total: 60 Hours**

REFERENCES

1. Grewal, B.S. and Grewal,J.S., " Numerical methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 7th Edition, Pearson Education Asia, New Delhi, 2007.
3. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 7th Edition, Tata McGraw-Hill, New Delhi, 2016.
4. R.A. Johnson and C.B. Gupta, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
5. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th edition, 2017.
6. Gupta S.C, and Kapur V.K "Fundamentals of Applied Statistics", Sultan Chand, New Delhi, 4th Edition, 2014.

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U18MEI4201 **STRENGTH OF MATERIALS**

L	T	P	J	C
3	0	2	0	4

Course Outcomes

After successful completion of the course, the student would be able to

CO 1 Apply fundamental concepts and compute simple stresses and deformations in structural members.

CO 2 Construct shear force and bending moment diagrams for statically determinate beams and determine stress distribution.

CO 3 Compute slope and deflection in statically determinate beams.

CO 4 Examine the buckling failure in columns and calculate strain energy under varying load conditions.

CO 5 Solve problems on shafts and springs subjected to twisting moment.

CO 6 Apply the concepts of complex stress system in 2D systems and in thin walled containers.

Pre-requisite:U18MET3002- Engineering Mechanics

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M		M									M	
CO2	S	M											M	
CO3	M	W		M									M	
CO4	M	W		M									M	
CO5	S	M		M									M	
CO6	M	W											M	

Course Assessment methods:

DIRECT

1. Continuous Assessment Test I, II (Theory component)
2. Assignment; Group Presentation, Project
3. Demonstration etc (as applicable) (Theory component)
4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)
5. Model Examination (lab component)
6. End Semester Examination (Theory and lab components)

INDIRECT

1. Course-end survey

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SIMPLE STRESSES AND STRAINS **9 hours**

Stress and strain - Stress-strain diagrams - Factor of safety – Stresses and strains in stepped bars and uniformly varying sections – Stresses in composite bars due to axial loads and temperature - Relationships among elastic constants.

SHEAR AND BENDING IN BEAMS **9 hours**

Shear force and bending moment diagrams for statically determinate beams. Theory of simple bending - Stress distribution along length and in beam section – Shear stresses in beams.

DEFLECTION OF BEAMS **7 hours**

Slope and deflection in determinate beams - Double integration method, Macaulay's method, Moment area method.

BUCKLING OF COLUMNS AND STRAIN ENERGY **6 hours**

Columns – End conditions – Euler's formula – Rankine's formula. Strain energy under gradual, sudden and impact loading

TORSION **7 hours**

Torsion of circular and hollow shafts - Elastic theory of torsion - Stresses and deflection in solid and hollow shafts - stepped shaft - Shafts in series and parallel. Springs - closed and open coiled helical springs.

COMPLEX STRESSES **7 hours**

State of stress at a point - Normal and Shear stresses on any plane - Principal stresses and strains in two dimension – Analytical method, Mohr's circle method. Hoop and longitudinal stresses in thin cylinders and shells.

INTEGRATED LAB EXPERIMENTS

1. Tension test on a mild steel rod
2. Shear test on a mild steel rod
3. Torsion test on mild steel rod
4. Hardness test on metals - Brinell and Rockwell Hardness
5. Deflection test on beams
6. Compression test on helical springs
7. Tensile test on helical springs
8. Impact Test

Theory: 45 **Tutorial: 0** **Practical: 30** **Project: 0** **Total: 75 Hours**

REFERENCES:

1. Popov E. P, "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 2007.

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2. Rajput R. K, “A Textbook of Strength of Materials”, S. Chand, 2007.
3. Subramanian R., “Strength of materials”, Oxford University Press, New Delhi, 2005
4. Bansal R. K, “Strength of materials”, Laxmi Publications, New Delhi, 2007.
5. William A.Nash, “Theory and Problems of Strength of materials, Schaum’s Outline series”, Tata McGraw-Hill, New Delhi, 2007.

Approved by BoS Chairman

U18MEI4202 **FLUID MECHANICS AND MACHINERY**

L	T	P	J	C
3	0	2	0	4

Course outcomes

After successful completion of the course, the student would be able to

CO 1 State and explain various fluid properties.

CO 2 Apply the knowledge of fluid statics for solving the problems in buoyancy and manometers.

CO 3 Solve problems in mass, momentum and energy balance equations in fluid dynamics.

CO 4 Determine the flow rate through Venturi-meter and orifice meter.

CO 5 Analyze the performance of turbines and pumps.

CO 6 Illustrate the various tools for solving fluid dynamic problems.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
CO's	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	M										M	S	
CO2	S	M							M	M			M	
CO3	S	S		M					S	S			M	
CO4	S	M		M					M	M		M	M	
CO5	S	S		M					M	M		M	M	
CO6	W					M							W	

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory component) 2. Assignment; Group Presentation, Project 3. Demonstration etc (as applicable) (Theory component) 4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component) 5. Model Examination (lab component) 6. End Semester Examination (Theory and lab components)
INDIRECT
1. Course-end survey

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FLUID PROPERTIES, STATICS AND KINEMATICS **10 Hours**

Fluid Properties: Importance & applications of fluid mechanics. Solid vs Fluid - Units and Dimensions – Properties of fluids (Definition only)-Mass density – Specific weight – Specific volume – Specific gravity – Viscosity – Compressibility – Surface tension – Capillarity – Vapor pressure.

Fluid Statics: Hydrostatic equation –Forces on plane and curved surfaces- Buoyancy – Metacentre – Simple and differential manometers. Fluid Kinematics: Path line – Stream line – Streak line – Stream and Potential functions – Flownets.

FLUID DYNAMICS **10 Hours**

Fluid Element and properties - Lagrangian vs Eulerian description – Governing equations: Mass balance (Continuity equation) – Newton's second law (momentum equation- statement only) – First law of thermodynamics (Energy equation-statement only). Non-viscous flows (Euler's equation) – Frictionless flows (Bernoulli's equation), Introduction to CFD.

Case study (not for exam): Demonstration of solving Euler's and Navier-Stokes equation using analysis tools like ANSYS, HyperWorks etc.

FLUID FLOW AND DIMENSIONAL ANALYSIS **10 Hours**

Laminar and turbulent flows through pipe – Hagen-Poiseuille equation – Darcy-Weishbach equation – Major and Minor losses.
Dimensional Analysis- Buckingham's π theorem- Discharge and velocity measurements- venture meter and pitot tube.

HYDRAULIC TURBINES **8 Hours**

Force exerted on moving plate/ vanes- Definition and classifications- Pelton, Francis, Propeller and Kaplan turbine: Working principles- Velocity triangle – Work done – specific speed – efficiencies – Performance curve for turbines.

HYDRAULIC PUMPS **7 Hours**

Definition and classifications- Centrifugal and Reciprocating Pumps: Working principles- Indicator diagram – Specific speed – efficiency and performance curves - Cavitation in pumps.

INTEGRATED LAB EXPERIMENTS

1. Determination of the Coefficient of discharge of a given Orifice meter.
2. Determination of the Coefficient of discharge of a given Venturi meter.
3. Characteristic curves of centrifugal / reciprocating pump.
4. Performance characteristics of Pelton wheel.
5. Performance characteristics of Francis turbine.

Theory: 45 **Tutorial: 0** **Practical: 30** **Project: 0** **Total: 75 Hours**

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REFERENCES:

1. P.N. Modi & S.M. Seth, “Hydraulics and fluid mechanics including hydraulic machines”, Standard book house, 2005.
2. R.K. Bansal,“Fluid mechanics and hydraulic machines”, Laxmi Publications (P) Ltd, 2006.
3. K.L. Kumar,“Engineering fluid mechanics”, Eurasia publishing house, 2001.
4. V.L. Streeter – “Fluid mechanics”, McGraw-Hill, 2002.
5. White, F.M., “Fluid Mechanics”, Tata McGraw-Hill, New Delhi, 2003.
6. Versteeg, H.K, and Malalasekera, W., “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Pearsons, 2007.

U18MET4003	KINEMATICS OF MACHINERY	L	T	P	J	C
		3	0	2	0	4

After successful completion of the course, the student would be able to

CO 1: Apply the fundamental concepts in developing various mechanisms
CO 2: Analyze velocity and acceleration in planar mechanisms
CO 3: Synthesize simple mechanisms such as 4-bar and slider crank mechanisms
CO 4: Construct the cam profile for specific follower motion.
CO 5: Determine appropriate gears for requirements.
CO 6: Compute the parameters in gear trains and determine the speeds in gear boxes.

Pre-requisite: U18MET3002 Engineering Mechanics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	W												W	
CO2	S	M		W					W				M	
CO3	M												M	
CO4	M	M		W									M	
CO5	M								W				M	
CO6	S			W					W				M	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. End semester exam	Course end survey

BASICS OF MECHANISMS **6 Hours**

Terminology and Definitions- Degree of freedom, mobility-Kutzbach criterion- Grashoff's law- Gruebler's criterion - Mechanical Advantage -Transmission angle – Coupler curves - Kinematic Inversions of 4- bar chain and slider crank chains - Description of common mechanisms -- Ratchets and pawl mechanisms- Indexing mechanisms - Rocking mechanisms - Straight line generators – Steering mechanisms

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KINEMATICS OF PLANE MECHANISMS **11 Hours**

General plane motion - Relative velocity method – Displacement, velocity and acceleration analysis in simple mechanisms - Instantaneous center method, Kennedy theorem – Coincident points – Coriolis component of acceleration - Analytical method of kinematic analysis.

SYNTHESIS OF MECHANISMS **7 Hours**

Mechanism synthesis – Motion generation, path generation and function generation – Chebychev’s spacing of accuracy points – Graphical and algebraic methods of synthesis of simple mechanisms such as 4 bar and slider crank mechanisms.

KINEMATICS OF CAM **8 Hours**

Classifications - Displacement diagrams - Uniform velocity, simple harmonic, uniform acceleration and retardation and cycloidal motions – Graphical layout of plate cam profiles – Derivatives of follower motion – High speed cams – Cams with specified contours - unbalance and wind up - Pressure angle and undercutting – spring surge, jump speed - Analysis of cam.

GEARS **6 Hours**

Introduction – Types – Terminology – Law of toothed gearing – Velocity of sliding – Involute and cycloidal tooth profiles – Interchangeable gears – Length of path and arc of contact – contact ratio – Interference and under cutting – Minimum number of teeth to avoid interference in pinion and gear – Nonstandard gear teeth.

GEAR TRAINS AND GEAR BOXES **7 Hours**

Gear trains –Simple, compound, reverted and epicyclic gear trains – Differentials.

Multi speed gear boxes – Speed ratio - Kinematic arrangement – Ray diagram.

Total:45 hours

REFERENCES:

1. Rattan, S.S.,“Theory of Machines”, Tata McGraw-Hill Publishing Company Ltd.,New Delhi, 2009.
2. Uicker, J.J., Pennock, G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press,New Delhi, 2009.
3. Thomas Bevan, “Theory of Machines”,CBS Publishers and Distributors, 2005.
4. Ghosh, A., and Mallick, A.K., “Theory of Mechanisms and Machines”, Affiliated EastWestPvt. Ltd., New Delhi, 2006.
5. Rao, J.S., and Dukkipati, R.V, “Mechanism and Machine Theory”, New Age International (P) Ltd Publishers. New Delhi, 2007.
6. Khurmi, R.S., and Gupta, J.K., “Theory of Machines”, S.Chand & Company, 2009.
7. Norton L Robert, “Kinematics and Dynamics of Machinery”,Tata McGraw Hill, Higher Education, 2008.

Approved by BoS Chairman

U18CHT4000	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	J	C
		3	0	0	0	0

(Common to Automobile/Aeronautical/Mechanical/Mechatronics Engineering)

Course Outcomes

After successful completion of the course, the student would be able to

CO 1: Analyze the impact of engineering solutions in a global and societal context

CO 2: Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems

CO 3: Highlight the importance of ecosystem and biodiversity

CO 4: Ability to consider issues of environment and sustainable development in his personal and professional undertakings

CO 5: Paraphrase the importance of conservation of resources.

CO 6: Play an important role in transferring a healthy environment for future generations

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M					S		M					M
CO2						M				M				
CO3							M							
CO4						M	S							
CO5							S							
CO6			W				S					M		

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

Course Content

OBJECTIVES

At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity.

Approved by BoS Chairman

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES **14 Hours**

Definition, scope and importance – Need for public awareness – Forest resources: Use and overexploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people

Water resources: Use and overutilization of surface and ground water, conflicts over water, dams benefits and problems - Water conservation, rain water harvesting, watershed management Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, case studies

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies

Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Wasteland reclamation – Role of an individual in conservation of natural resources

ECOSYSTEMS AND BIODIVERSITY **9 Hours**

ECOSYSTEM: Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Food chain, Food web, Energy flow in the ecosystem and Ecological pyramids - Ecological succession – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem

(d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

BIODIVERSITY : Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION **10 Hours**

Definition – Causes, effects and control measures of: (a) Air pollution - Organic and inorganic pollution - cyclone separator, electrostatic precipitator(b) Water pollution (c) Heavy metal pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards - Role of an individual in prevention of pollution – Pollution case studies – Solid waste and hazardous Management: Causes, effects and control measures from factories, small scale and large scale industries - waste minimization – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7 Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Resettlement and rehabilitation of people; its problems and concerns, case studies – Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Human Rights

HUMAN POPULATION AND THE ENVIRONMENT **5 Hours**

Population growth and explosion – Welfare Programme- Environment and human health

– Communicable disease – Role of Information Technology in Environment and human health – Case studies.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Miller T.G, “Environmental Science”, Wadsworth Publishing Co, 2013.
2. Masters G.M., and Ela W.P., “Introduction to Environmental Engineering and Science”, Pearson Education Pvt., Ltd.
3. Bharucha Erach, “The Biodiversity of India”, Mapin Publishing Pvt. Ltd., Ahmedabad India, 2002.
4. Trivedi R.K and Goel P.K., “Introduction to Air pollution”. Techno-science Publications. 2003.
5. Trivedi R.K., “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards”, Enviro Media, 1996.
6. Cunningham, W.P., Cooper, T.H.., &Gorhani E., “Environmental Encyclopedia”, Jaico Publication House, Mumbai, 2001
7. Wager K.D., “Environmental Management”, W.B. Saunders Co., USA, 1998
8. Townsend C., Harper J and Michael Begon, “Essentials of Ecology”, Blackwell science Publishing Co., 2003
9. Syed Shabudeen, P.S. “Environmental chemistry”, Inder Publishers, Coimbatore, 2013

Approved by BoS Chairman

L	T	P	J	C
3	0	2	0	4

U18EEI4207 ELECTRICAL DRIVES AND CONTROL

COURSE OUTCOMES:

After successful completion of this course, the students would be able to

CO1 Describe the construction, principle of operation and characteristics of DC motors

CO2 Distinguish the construction and operation various types of induction motors

CO3 Familiarize the speed control techniques for DC motor and induction motor

CO4 Describe the construction and operation of special electrical machines

CO5 Choose the suitable motor for specific application

PRE-REQUISITE

1. Engineering Physics

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	W											W	
CO2	M	W											W	
CO3		W	S		W							W		W
CO4	W		M		M							W		W
CO5		M	W	M									W	

COURSE ASSESSMENT METHODS

Direct
1. Continuous Assessment Test I, II 2. Model Examination(For Practical courses & Embedded courses) 3. Assignment, Open book test; Cooperative learning report, Group Presentation, Problem based learning, Project based learning, Mini Projects, Project report, Quiz, Role play, Self-Explanatory videos, Prototype or Product Demonstration etc. (as applicable) 4. End Semester Examination
Indirect
1. Course-end survey
2. Programme Exit survey
3.Placement/Higher education record
4.Feedback (Students, Employers, Parents, Professional body members, Alumni)

THEORETICAL COMPONENT CONTENTS:

DC MACHINES **9 Hours**

Introduction to Magnetic Circuits - Construction of DC machines- Principle, operation and Torque equation of DC motor- Types of DC motors- DC Shunt Motor and series motors- Characteristics and Applications

TRANSFORMERS AND AC MACHINES **9 Hours**

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Principle of transformers- Three phase induction motors- Principle of operation - Construction- Types- Single phase Induction motors- - Starting methods- Types -Applications.

SPEED CONTROL OF DC MOTORS **9 Hours**

Basic components of Electrical Drives -Factors influencing the choice of electrical drives-Speed control of DC Shunt Motors- Armature control - Field control - Single phase fully controlled converter fed DC motor- Four quadrant chopper fed DC motor- Applications

SPEED CONTROL OF INDUCTION MOTOR **9 Hours**

Speed control of three phase induction motor- Stator voltage control using SCR based voltage controller- Rotor resistance control-Constant V/F ratio control using VSI- Applications

SPECIAL ELECTRICAL MACHINES **9 Hours**

Construction and operation: PMDC motor, Variable reluctance stepper motor, BLDC motor, AC Servo motor and Permanent magnet synchronous motor- Applications

TEXTBOOKS:

1. V. K. Mehta and Rohit Mehta, "Principles of Electrical Machines", S. Chand & Co Ltd, 2006.
2. Gopal K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2015.

REFERENCES

1. Thereja .B.L, ―Fundamentals of Electrical Engineering and Electronics, S. Chand & Co Ltd, 2008.
2. J.B.Gupta, ―Theory and Performance of Electrical Machines, 14th Edition, S.K.Kataria and Sons, 2010, New Delhi.
3. S.K. Pillai, "A First Course on Electrical Drives", 3rd Edition, New Age International Publishers, New Delhi, 2014.

List of Experiments:

1. Load test on DC shunt motor
2. Load test on DC series motor
3. Speed control of DC shunt motor
4. Load test on single phase induction motor
5. Speed control of fully controlled converter fed DC motor
6. Speed control of three phase induction motor using V/f control
7. Speed control of BLDC motor
8. Speed control of Stepper motor
9. Study of Transformer
10. Study of four quadrant DC drive

Theory: 45 Tutorial: 0 Practical: 30 Project: 0 Total: 75 Hours

Approved by BoS Chairman

U18INI4600 ENGINEERING CLINIC - IV

L	T	P	J	C
0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own
- To help experiment with innovative ideas in design and team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Identify a practical problems and find a solution

CO2: Understand the project management techniques

CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

1. U18INI3600 Engineering Clinic III

CO/PO Mapping (S/M/W indicates strength of correlation)S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

Direct	**Indirect**
1. Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the fourth semester, students will focus primarily on Reverse engineering project to improve performance of a product

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ Multi-focus group of 5-6 students.
3. Groups can select to work on a specific tasks, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

Approved by BoS Chairman

U18MEP4704	INDUSTRIAL INTERNSHIP	L	T	P	J	C
		0	0	0	2	0

CO 1: Develop communication, interpersonal and other critical skills to meet the requirements of interview process.
CO 2: Apply ethical principles and norms of engineering practice in the Industrial Environment
CO 3: Communicate and collaborate effectively and appropriately within the team and outside the team
CO 4: Solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course
CO 5: Acquire employment contacts leading directly to a full-time job following graduation from college.
CO 6: Develop work habits and attitudes necessary for job success

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	W						M				S	S
CO2	S	M	W						M				S	S
CO3	S	M	W						M				S	S
CO4	S	M	W						M				S	S
CO5	S	M	W						M				S	S
CO6	S	M	W						M				S	S

Approved by BoS Chairman

V Semester

Approved by BoS Chairman

U18MEI5201 **THERMAL ENGINEERING**

L	T	P	J	C
3	0	2	0	4

(Use of standard thermodynamic tables, Mollier diagram, Psychometric chart and Refrigerant property tables are permitted in the examination)

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Explain the working principle and combustion characteristics of IC Engines.

CO 2: Calculate the performance parameters of Gas power cycles, IC Engines and estimate the fuel properties

CO 3: Explain the performance characteristics of steam nozzles.

CO 4: Discuss the importance of velocity diagrams and compounding in Turbines

CO 5: Calculate the various efficiencies of the air compressors.

CO 6: Explain the working principle of VCR & VAR systems.

Pre-requisite:1. U18MET3004- Engineering Thermodynamics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S			M					M	M			S	
CO2	S	M	S	M		W	W		M	M			S	
CO3	S		M						M	M			M	
CO4	S		S	M					M	M			M	
CO5	S		M	M			W		M	M			S	
CO6	S								M	M			S	

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory)
2. Assignments
3. Experimental results analysis/viva
4. Model Examination (lab)
5. End Semester Examination (Theory and lab components)
INDIRECT
1. Course-end survey

INTERNAL COMBUSTION ENGINES **9 Hours**

Engine components and functions - timing diagram. Fuel supply systems- CRDI, MPFI, Ignition Systems - Combustion phenomenon – Knocking and Detonation – Octane, Cetane numbers- Air-fuel

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ratio calculation, Lubrication system and cooling system.

GAS POWER CYCLES &ENGINE PERFORMANCE 9 Hours

Otto, Diesel, Dual, Brayton cycles (Air standard efficiency derivation only), Calculation of mean effective pressure and air standard efficiency, Actual and theoretical PV diagram of Four stroke engines, Actual and theoretical PV diagram of two stroke engines. Exhaust gas analysis - Recent trends in pollution control norms

STEAM NOZZLES AND TURBINES 9 Hours

Flow of steam through nozzles, shapes of nozzles, effect of friction – Nozzle efficiency- General relationship between area, velocity and pressure in nozzle flow. Critical pressure ratio - Impulse and reaction principles, compounding, and velocity diagrams for simple turbines, speed regulations – governors. Reheating the steam- Bleeding.

AIR COMPRESSOR 9 Hours

Classification - Reciprocating Air Compressor - working principle, work of compression with and without clearance. Multistage air compressor and inter cooling (Descriptive treatment only), Rotary Compressors – Centrifugal Compressor and axial flow compressor (Descriptive treatment only), Screw Compressors.

REFRIGERATION AND AIR CONDITIONING 9 Hours

Fundamentals of refrigeration and air conditioning - Vapour compression refrigeration cycle- super heat, sub cooling- Performance calculations- working principle of vapour absorption system, Ammonia-Water, Lithium boride- water systems (Description only) – Alternate refrigerants- Air conditioning systems: types, working principles- Psychrometry - Cooling Load calculations – Concept of RSHF, GSHF, ESHF.

LIST OF EXPERIMENTS:

1. Valve Timing and Port Timing Diagrams.
2. Performance Test on Multi Cylinder Diesel Engine by Hydraulic loading.
3. Heat Balance Test on Diesel Engine by Electrical loading.
4. Morse Test on Multi cylinder Petrol Engine.
5. Performance and emission Test on single cylinder petrol engine.
6. Determination of Frictional Power by retardation test.
7. Determination of Viscosity of given oil.
8. Determination of Flash Point and Fire Point.
9. Performance test on reciprocating air compressor.
10. Study on CRDI and MPFI engines.
11. Study of data acquisition system for engine experiments.

Theory: 45 Tutorial: 0 Practical: 30 Project: 0 Total: 75 Hours

Approved by BoS Chairman

REFERENCES:

1. Sarkar, B.K, “Thermal Engineering”, Tata McGraw-Hill Publishers,2007.
2. Kothandaraman.C.P., Domkundwar.S, Domkundwar.A.V., “A course in thermal Engineering”, Dhanpat Rai & sons,2002.
3. Arora, C.P., “Refrigeration and Air conditioning”, Tata McGraw-Hill Publishers,2007.
4. Ganesan.V., “Internal Combustion Engines”, Tata McGraw-Hill,2007.

Approved by BoS Chairman

U18MEI5202 ENGINEERING METROLOGY AND QUALITY CONTROL

L	T	P	J	C
3	0	2	0	4

Course Outcomes:

After successful of the course, the student would be able to:

CO 1: Apply knowledge of linear and angular measurements and effective communication for engineering practice.

CO 2: Apply knowledge of form measurements with effective communication for engineering application.

CO 3: Explain the working principles of advanced instruments / equipment's used in metrology.

CO 4: Construct various control charts for the variables and attributes.

CO 5: Apply knowledge of various sampling methods, concepts and reliability.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	M												M
CO2	S	M												M
CO3	M	M												M
CO4	S	M		M										
CO5	S	M		M										

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory) 2. Assignments 3. Experimental results analysis/viva 4. Model Examination (lab) 5. End Semester Examination (Theory and lab components)
INDIRECT
1. Course-end survey

LINEAR AND ANGULAR MEASUREMENTS **9 hours**

Length Standards - Length Measuring instruments - Vernier instruments - micrometer, height gauge, dial indicators, Bore gauges, Slip gauges, Comparators - Mechanical, Electrical, Optical and Pneumatic, Optical Projector. Angle measuring instruments - Bevel protractor, Spirit level, Sine bar, Autocollimator, Angle Decker.

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FORM MEASUREMENT **9 hours**

Screw thread terminology- Measurement of effective diameter by two wire and three wire methods - errors in threads- Measurement of pitch, profile errors and total composite errors, Gear tooth terminology-Methods of measurements of run out, pitch, profile, lead, backlash, tooth thickness-composite method of inspection - Parkinson gear tester - Measurement of surface finish - Stylus probe instruments - Tomlinson and Talysurf instrument-Straightness, Flatness and Roundness measurement.

ADVANCES IN METROLOGY **9 hours**

Precision instruments based on Laser- laser interferometer – Universal Measuring Machine- Tool maker's microscope - Coordinate Measuring Machine (CMM): need, construction, types, applications-Computer Aided Inspection, Machine Vision - Introduction to Nanometrology

PROCESS CONTROL FOR VARIABLES AND ATTRIBUTES **9 hours**

Definition and concept of quality - significance of SQC - benefits and limitations of SQC - Quality assurance - Quality cost - Process capability – process capability studies – Construction and uses of control chart – Control chart for variables – X bar chart, R- chart, S-chart- Control chart for attributes – c- chart, u- chart, p- charts.

ACCEPTANCE SAMPLING **9 hours**

Lot by lot sampling - probability of acceptance in single, double, multiple sampling techniques – OC curves – producers' risk and consumers risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD.

LIST OF EXPERIMENTS:

1. Study of linear measuring instruments.
2. Linear Measurement using Vernier height gauge and slip gauge.
3. Angular measurement using sine bar and bevel protector.
4. Measurements of gear tooth dimensions using gear tooth Vernier and error of composite gear tooth using gear roll tester.
5. Measurement of screw thread parameters using Tool Makers Microscope and Profile Projector.
6. Measurement of surface roughness of machined components.
7. A study of co-ordinate measuring machine.
8. Process capability study

Theory: 45 hours **Practicals: 15 hours** **Total: 60 hours**

C. Velmurugan

Approved by BoS Chairman

REFERENCES:

1. Jain R.K., “Engineering Metrology”, Khanna Publishers,2005.
2. Gupta S.C, “Engineering Metrology”, Dhanpat rai Publications, 2005.
3. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2006.
4. Anthony, D.M. Engineering Metrology, Pergamon Press, First Edition, 1986.
5. Shotbolt, C.S. and Galyer. J. Metrology for Engineers, Cassell Publ., Fifth Edition, 1990.
6. Douglas C. Montgomery, “Introduction to Statistical Quality Control”, John wiley & sons, 2005.

Approved by BoS Chairman

U18MET5003 **DESIGN OF MACHINE ELEMENTS**

(Use of approved Design Data Book is permitted in the Examination)

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Apply the concept of steady stresses in design of machine elements subjected to steady loads.

CO 2: Solve problems in machine elements subjected to varying loads

CO 3: Design shafts and couplings for various applications

CO 4: Select bearings for specific applications.

CO 5: Design temporary and permanent joints.

CO 6: Design energy storing springs and flywheel.

Pre-requisite:1. U18MEI4201- Strength of Materials

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M	S		S		W	M					S	
CO2		M	S		S		W	M					S	
CO3	S		S		S		W	M					M	
CO4	S		S		S		W	M					W	
CO5	S		S		S		W	M					M	
CO6	S		S		S		W	M					W	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. End semester exam	Course end survey

STEADY STRESSES IN MACHINE MEMBERS **7 hours**

Introduction to the design process – Product development cycle- factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers – Direct, Bending and Torsional stress – Impact and shock loading, eccentric loading – Design of curved beams - Theories of failure

STRESS CONCENTRATION AND VARIABLE STRESSES IN MACHINE MEMBERS **5 hours**

Stress concentration – Design for variable loading – Soderberg, Goodman and Gerber relations

Approved by BoS Chairman

DESIGN OF SHAFTS AND COUPLINGS **9 hours**

Design of shafts based on strength, rigidity and critical speed – Design of keys, keyways and splines - Design of rigid and flexible couplings

DESIGN OF BEARINGS **8 hours**

Sliding contact and rolling contract bearings – Design of hydrodynamics journal bearings – selection of rolling contact bearings.

DESIGN OF TEMPORARY AND PERMANENT JOINTS **9 hours**

Threaded fasteners - Design of bolted joints including eccentric loading, Knuckle joints, Cotter joints – Design of welded joints - Design of riveted joints.

DESIGN OF ENERGY STORING ELEMENTS **7 hours**

Design of various types of springs, helical springs, leaf springs - Design of flywheels considering stresses in rims and arms

Theory : 45 hours **Total: 45 hours**

REFERENCES:

1. Shigley J.E and Mischke C.R., "Mechanical Engineering Design", Tata McGraw-Hill, 2003.
2. Bhandari V.B, "Design of Machine Elements", Tata McGraw-Hill Book Co, 2007.
3. Sundararajamoorthy T. V, Shanmugam. N, "Machine Design", Anuradha Publications, Chennai, 2003.
4. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
5. Ugural A.C, "Mechanical Design – An Integral Approach", McGraw-Hill Book Co, 2004.

Approved by BoS Chairman

U18MET5004	**TURBO MACHINES**	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: Apply the principles of turbo machines

CO2: Design and estimate different parameters for centrifugal fans.

CO3: Design and analyze flow parameters in blowers

CO4: Solve problems on centrifugal compressors

CO5: Design simple stage problems in axial flow compressors

CO6: Calculate and analyze flow parameters in radial flow gas turbines

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M											S	
CO2	S	M											S	M
CO3	S	M		M									S	M
CO4	S	S		M									S	M
CO5	S	S											S	
CO6	S	M											S	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. End semester exam	Course end survey

TURBOMACHINERY PRINCIPLES **9 hours**

Energy transfer between fluid and rotor, classification of fluid machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency for compressors and turbines

CENTRIFUGAL FANS AND BLOWERS **9 hours**

Types- stage and design parameters-flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise, simple problems

CENTRIFUGAL COMPRESSOR **9 hours**

Construction details, work, efficiency, h-s diagram, impeller flow losses, slip factor, diffuser analysis, losses and performance curves, simple problems.

Approved by BoS Chairman

AXIAL FLOW COMPRESSOR **9 hours**

Stage velocity diagrams, enthalpy - entropy diagrams, stage losses and efficiency, work done factor, simple stage design problems and performance characteristics, simple problems.

RADIAL FLOW GAS TURBINES **9 hours**

Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics, simple problems

LECTURE: 45 hours **TOTAL: 45 hours**

TEXTBOOK

1. Yahya, S.H., " Turbines, Compressor and Fans ", Tata McGraw Hill Publishing Company, 2013

REFERENCES

1. Bruneck, Fans, Pergamom Press, 1973.

2. Earl Logan, Jr., Handbook of Turbomachinery, Marcel Dekker Inc., 1992.

3. Dixon, S.I., Fluid Mechanics and Thermodynamics of Turbomachinery, Pergamon Press, 1990.

4. Shepherd, D.G., Principles of Turbomachinery, Macmillan, 1969.

5. Stepanoff, A.J., Blowers and Pumps, John Wiley and Sons Inc. 1965.

6. Ganesan, V., Gas Turbines, Tata McGraw Hill Pub. Co.,1999.

7. Gopalakrishnan .G and Prithvi Raj .D, A Treatise on Turbomachines, Scifech Publications (India) Pvt. Ltd., 2002.

Approved by BoS Chairman

U18MEI5205 **DYNAMICS OF MACHINERY**

L	T	P	J	C
3	0	2	0	4

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Analyze the static and dynamic force in mechanical systems. Evaluate the fluctuation of energy stored in flywheel.

CO 2: Determine the unbalanced force in reciprocating and rotating mass

CO 3: Apply the fundamental concepts of vibrating system to predict the natural frequency.

CO 4: Estimate the frequency of damped and forced vibrating systems

CO 5: Calculate the speed range of governors.

CO 6: Determine the gyroscopic couple.

Pre-requisite: 1. U18MET5004 Kinematics of Machinery

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M							W				M	
CO2	S	M		M					W				M	
CO3	M			M					W				M	
CO4	M			M					W				M	
CO5	M			M					W				M	
CO6	M			M					W				M	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. End semester exam	Course end survey

FORCE ANALYSIS AND FLYWHEELS **10 Hours**

Static force analysis of mechanisms - Inertia force and Inertia torque – Dynamic force analysis - Dynamic Analysis in Reciprocating Engines – Gas Forces - Equivalent masses - Crank shaft torque. Turning moment diagrams – Fluctuation of energy, speed - Flywheels of engines and punching press

BALANCING **8 Hours**

Static and dynamic balancing – Balancing of rotating masses - Balancing of reciprocating masses in a single cylinder engine - Balancing in multi-cylinder engines – Firing order.

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FREE VIBRATION **9 Hours**

Basic features of vibratory systems - Basic elements and lumping of parameters - Degrees of freedom - Single degree of freedom - Free vibration - Equations of motion - Natural frequency - Whirling of shafts and critical speed - Torsional vibration of two and three rotor systems.

DAMPED AND FORCED VIBRATIONS **8 Hours**

Damped vibration - Types of damping - Response to periodic forcing - Harmonic Forcing – Forced vibration caused by unbalance – Force transmissibility and amplitude transmissibility - Vibration isolation.

GOVERNORS **5 Hours**

Governors - Types - Centrifugal governors – Porter, Proell and Hartnell governors – Controlling force - Characteristics.

GYROSCOPES **5 Hours**

Gyroscopes - Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in aeroplanes, ships and automobiles.

INTEGRATED LABORATORY EXPERIMENTS

1. Characteristic cures of Porter and Hartnell governors
2. Motorized gyroscope
3. Damped vibration
4. Balancing of reciprocating masses
5. Balancing of rotating masses
6. (a) Longitudinal vibration in helical spring (b) Verification of Dunkerley's rule
7. (a) Single rotor system (b) Vibrating table
8. Critical speed of whirling of shaft
9. Compound Pendulum

Theory : 45 Hours **Practical: 30 Hours** **Total: 75 Hours**

REFERENCES:

1. Rattan S.S., "Theory of Machines", Tata McGraw-Hill Publishing Company, New Delhi, 2009.
2. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2005.
3. Ghosh A. and MallickA.K., "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi, 2006.
4. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press,New Delhi, 2009.

Approved by BoS Chairman

5. Rao J.S. and DukkipatiR.V., “Mechanism and Machine Theory”, New International Limited Publishers, New Delhi, 2007.
6. John Hannah and Stephens R.C., “Mechanics of Machines”, Viva low-Priced Student Edition, 2006.
7. Sadhu Singh “Theory of Machines” Pearson Education India, 2006.

STANDARDS:

1. IS 11717: 2000, Vocabulary on Vibration and Shock
2. IS 13301: 1992, Guidelines for vibration isolation for machine foundations
3. IS 10000: Part 7: 1980, Methods of tests for internal combustion engines: Part 7 Governing tests for constant speed engines and selection of engines for use with electrical generators
4. IS 13274: 1992, Mechanical vibration - Balancing – Vocabulary
5. IS 13277: 1992, Balancing machine - Description and evaluation

VI Semester

C. Velmurugan

Approved by BoS Chairman

U18MEI6201 **HEAT AND MASS TRANSFER** **L T P J C**

(Use of Standard Heat and Mass Transfer Data Book is permitted) **3 0 2 0 4**

L	T	P	J	C
3	0	2	0	4

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Apply steady state heat conduction problems for composite systems and fins.

CO 2: Solve transient heat conduction problems.

CO 3: Solve problems in natural and forced convection for internal and external flows.

CO 4: Calculate the effectiveness of heat exchanger using LMTD and NTU methods.

CO 5: Illustrate radiation shape factors for various geometries.

CO 6: Explain the phenomenon of diffusion and convective mass transfer.

Pre-requisite: 1. U18MET3004 – Engineering Thermodynamics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S			M					M	M			S	
CO2	S			M					M	M			S	
CO3	S	M		M					M	M			M	
CO4	S	S		M					M	M			S	
CO5	M			M					W	W			W	
CO6	M								W	W			W	

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory component) 2. Assignment; Group Presentation, Project 3. Demonstration etc (as applicable) (Theory component) 4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component) 5. Model Examination (lab component) 6. End Semester Examination (Theory and lab components)
INDIRECT
2. Course-end survey

CONDUCTION **9 hours**

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – Fourier Law of Conduction - General Differential Conduction equation in Cartesian and Cylindrical Coordinate systems – One Dimensional Steady State Heat Conduction through Plane Wall, Cylindrical and Spherical systems – Composite Systems – Critical thickness of insulation - Conduction with Internal Heat Generation – Extended Surfaces – Numerical

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Methods of One dimensional Heat conduction- Unsteady Heat Conduction – Lumped Analysis, Infinite and semi Infinite solids using Heislers Chart.

CONVECTION **9 hours**

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar, Turbulent and Combined flows – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical, Horizontal and Inclined Plates, Cylinders and Spheres.

HEAT EXCHANGERS **9 hours**

Nusselts theory of condensation - Regimes in boiling - Correlations in condensation and boiling - Types of Heat Exchangers- compact heat exchanger – Overall Heat Transfer Coefficient – Fouling Factors - LMTD and Effectiveness – NTU methods of Heat Exchanger Analysis.

RADIATION **9 hours**

Basic Concepts, Laws of Radiation – Black Body Radiation – Grey body radiation –radiation shield - Shape Factor Algebra (Plates, parallel, perpendicular, parallel circular disc) – Gas radiations (qualitative study).

MASS TRANSFER **9 hours**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

Theory: 45 hours **Total: 45 hours**

LIST OF EXPERIMENTS:

1. Thermal conductivity measurement using a two-slab guarded hot plate apparatus
2. Thermal conductivity measurement of an insulation using lagged pipe apparatus.
3. Determination of convective heat transfer coefficient and rate of Heat transfer - free and forced convection.
4. Determination of rate of Heat transfer from pin-fin - natural and forced convection mode.
5. Estimation of effectiveness of tube – in – tube parallel flow and counter flow heat exchanger mode by using LMDT and NTU method.
6. Determination of emissivity and radiation factor for the given test specimen using Stefan-Boltzman emissivity apparatus.
7. Determination of COP of the given VCR test rig.
8. Determination of COP of the given air conditioning test rig.

Approved by BoS Chairman

REFERENCES:

1. Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer”, New Age International,2008.
2. Yunus Cengal, “Heat and Mass Transfer”, Tata McGraw Hill,2008.
3. Holman J.P, “Heat Transfer” Tata Mc Graw Hill,2007.
4. Ozisik M.N, “Heat Transfer”, McGraw-Hill Book Co,2001.
5. Nag P.K, “Heat Transfer”, Tata McGraw-Hill, New Delhi, 2002.
6. Eckert, E.R.G, ‘Heat and mass transfer “ Mc Graw hill, 1959.
7. Frank P. Incropera and David P. DeWitt, “Fundamentals of Heat and Mass Transfer”, John Wiley and Sons, March 2006.:

Theory: 45 hours **Practical: 30 hours** **Total: 75 Hours**

Approved by BoS Chairman

U18MET6002 **OPERATIONS RESEARCH**

L	T	P	J	C
3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to:

CO1: Apply linear programming model and assignment model to domain specific situations

CO2: Analyze the various methods under transportation model and apply the model for testing the closeness of their results to optimal results

CO3: Apply the concepts of PERT and CPM for decision making and optimally managing projects

CO4: Analyze the various replacement and sequencing models and apply them for arriving at optimal decisions

CO5: Analyze and apply appropriate inventory techniques in domain specific situations.

CO6: Analyze and apply appropriate queuing theories in domain specific situations

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S		S										
CO2	S	S		S										
CO3	S	S		S										
CO4	S	S		S										
CO5	S	S		S										
CO6	S	S		S										

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

LINEAR MODEL **9 hours**

The phases of OR study – formation of an L.P model – graphical solution – simplex algorithm – artificial variables technique (Big M method, two phase method), duality in simplex

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TRANSPORTATION AND ASSIGNMENT PROBLEM 9 hours

Transportation model – Initial solution by North West corner method – least Cost method – VAM. Optimality test – MODI method and steppingstone method. Assignment model – formulation – balanced and unbalanced assignment problems

PROJECT MANAGEMENT BY PERT & CPM 9 hours

Basic terminologies – Constructing a project network – Scheduling computations – PERT - CPM – Resource smoothening, Resource leveling, PERT Cost

REPLACEMENT AND SEQUENCING MODELS 9 hours

Replacement policies - Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies).

Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem

INVENTORY AND QUEUING THEORY 9 hours

Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management.

Queuing system and its structure – Kendall's notation – Common queuing models - M/M/1: FCFS/∞/∞ - M/M/1: FCFS/n/∞ - M/M/C: FCFS/∞/∞ - M/M/1: FCFS/n/m

Theory: 45 hours **Total: 45 hours**

REFERENCES:

1. Taha H.A., "Operation Research", Pearson Education,2011.
2. Hira and Gupta "Introduction to Operations Research", S.Chand and Co.2007.
3. Hira and Gupta "Problems in Operations Research", S.Chand and Co.2008
4. Wagner, "Operations Research", Prentice Hall of India, 2000.
5. Bhaskar, S., "Operations Research", Anuradha Agencies,2015.

Approved by BoS Chairman

U18MEI6203 FINITE ELEMENT ANALYSIS

L	T	P	J	C
3	0	2	0	4

Course outcomes
After successful completion of the course, the students should be able to
CO 1: Solve problems by applying standard finite element techniques.

CO 2: Analyze 1-D finite elements and to build the stiffness matrix.

CO 3: Examine 2-D finite element continuum for structural applications.

CO 4: Solve 1-D and 2-D heat transfer problems using finite element approach.

CO 5: Apply axisymmetric formulation for specific applications.

CO 6: Make use of finite element principles in iso-parametric applications.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S												W	
CO2	M				M				W				M	
CO3	M	M	M						W				W	
CO4	S	M			M				W				M	
CO5	M	M			M								M	
CO6	S												W	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION **9 Hours**

Historical background– Matrix approach – Application to the continuum – Discretisation – Matrix algebra – Gaussian elimination – Governing equations for continuum – Classical Techniques in FEM – Weighted residual method – Rayleigh Ritz method

ONE DIMENSIONAL PROBLEMS **9 Hours**

Finite element modeling – Coordinates and shape functions- Potential energy approach – Galarkin approach – Assembly of stiffness matrix and load vector – Finite element equations – Quadratic shape functions – Applications to plane trusses- One dimensional steady state conduction and convective heat transfer problems.

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TWO-DIMENSIONAL CONTINUUM 9 Hours

Introduction – Finite element modeling – Scalar valued problem – Poisson's equation – Laplace equation –Triangular elements – Element stiffness matrix – Force vector – Galarkin approach - Stress calculation.

AXISYMMETRIC CONTINUUM 9 Hours

Axisymmetric formulation – Element stiffness matrix and force vector – Galarkin approach – Body forces – Stress calculations – Boundary conditions.

ISOPARAMETRIC ELEMENTS FOR TWO-DIMENSIONAL CONTINUUM 9 Hours

The four-node quadrilateral – Shape functions – Element stiffness matrix and force vector – Numerical integration – Stiffness– Stress calculations – Four node quadrilateral for axisymmetric problems.

Theory : 45 Hours Practical : 30 Hours Total : 75 Hours

<u>Practical:</u>

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

REFERENCES:

1. Chandrupatla T.R., and Belegundu A.D., "Introduction to Finite Elements in Engineering", Prentice Hall, 2011.
2. David V Hutton "Fundamentals of Finite Element Analysis" McGraw-Hill Int. Edition, 2005.
3. Rao S.S., "The Finite Element Method in Engineering", Pergammon Press, 2005.
4. Reddy J.N.,"Finite Element: An Introduction to Finite Element Method", McGraw-Hill education,2005.
5. O.C.Zienkiewicz and R.L.Taylor, "The Finite Element Methods", Butterworth Heineman,2005.
6. Logan D.L, "A first course in the Finite Element Method", Thomson Learning, 2010.

Approved by BoS Chairman

18MET6004 **DESIGN OF TRANSMISSION SYSTEMS**

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Choose suitable flexible drive for specific application.

CO 2: Design spur and helical gear by considering strength and life.

CO 3: Estimate the dimensions of bevel and worm gears

CO 4: Construct the gear box for suitable application.

CO 5: Design braking system for various applications.

CO 6: Apply the concepts of pressure and wear theories to design clutches.

Pre-requisite: U18MET5003 – Design of Machine Elements

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	M	W						W				S	
CO2	S	M	W						W				S	
CO3	S	M	W						W				S	
CO4	S	M	W						W				S	
CO5	S	M	W						W				S	
CO6	S	M	W						W				S	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. Tutorial 6. End semester exam	Course end survey

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DESIGN OF FLEXIBLE ELEMENTS 8 Hours

Dynamic aspects of belt drives – ratio of driving tensions - Maximum power transmitted by a belt drive. Selection of Flat belts and V belts – pulleys -Wire ropes and pulleys – Selection of Transmission chains and Sprockets. Design of pulleys and sprockets.

SPUR GEARS AND HELICAL GEARS 8 Hours

Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Gear materials – Module and Face width-power rating calculations based on strength and wear considerations - Helical Gears – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces and stresses. Estimating the size of the spur and helical gears.

BEVEL AND WORM GEARS 8 Hours

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: terminology, Merits and demerits. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

DESIGN OF GEAR BOXES 6 Hours

Geometric progression - Standard step ratio - Design of sliding mesh gear box - Constant mesh gear box. – Design of multi speed gear box- Industrial Case studies in Gear Box Design

DESIGN OF BRAKES 8 Hours

Dynamic aspects of braking – Braking Torque in block, band and internal expanding shoe brake - Design brakes

DESIGN OF CLUTCHES 7 Hours

Dynamic aspects of clutches – Torque transmitted in plate clutches, cone clutches and jaw clutches - Design of clutches

Theory :45 Hrs **Total:60Hrs**

REFERENCES:

1. Rattan, S.S.,"Theory of Machines", Tata McGraw-Hill Publishing Company Ltd.,New Delhi, 2009.
2. Shigley J.E and Mischke C.R., "Mechanical Engineering Design", Tata McGraw-Hill Education, 2014.
3. Sundararajamoorthy T.V., Shanmugam N., "Machine Design", Anuradha Publications, Chennai, 2015.
4. Maitra G.M., Prasad L.V., "Hand book of Mechanical Design", Tata McGraw-Hill, 1995.
5. Bhandari, V.B., "Design of Machine Elements", Tata McGraw-Hill Education, 2010.
6. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.

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7. Hamrock B.J., Jacobson B., Schmid S.R., “Fundamentals of Machine Elements”, McGraw-Hill Book Co., 2013.

8. UguralA.C,"Mechanical Design, An Integrated Approach", McGraw Hill Education, 2003.

9. Khurmi, R.S., and Gupta, J.K., “Theory of Machines”, S.Chand& Company, 2009.

STANDARDS:

1. IS 4460: Parts 1 to 3: 1995, Gears – Spur and Helical Gears – Calculation of Load Capacity.

2. IS 7443: 2002, Methods of Load Rating of Worm Gears

3. IS 15151: 2002, Belt Drives – Pulleys and V-Ribbed belts for Industrial applications – PH, PJ, PK, Pl and PM Profiles: Dimensions

4. IS 2122: Part 1: 1973, Code of practice for selection, storage, installation, and maintenance of belting for power transmission: Part 1 Flat Belt Drives.

5. IS 2122: Part 2: 1991, Code of practice for selection, storage, installation, and maintenance of belting for power transmission: Part 2 V-Belt Drives.

Approved by BoS Chairman

U18MET6005 APPLIED MATERIALS ENGINEERING

L	T	P	J	C
3	0	0	0	3

CO1: Apply the knowledge on Metal Structure Crystallization and Plastic Deformation

CO2: Apply the knowledge on the various phase diagrams and their applications

CO3: Apply the knowledge of failure mechanisms in failure analysis of metallic materials.

CO4: Apply the students will acquire knowledge on Fe-Fe_3C phase diagram, various micro-structures, and alloys

CO5: Apply the students will get knowledge on mechanical properties of materials and their measurement

CO6: Explain properties, structure and applications of composites, ceramics and nanomaterials

OBJECTIVES:

To introduce the essential principles of materials science for mechanical and related engineering applications.

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M		M		M				M			S
CO2	S		S		M			M						S
CO3	S		M				M							S
CO4	S		M		M			M			M			S
CO5	S		M											S
CO6	S		M		M		M	M			M			S

Metal Structure, Crystallization and Plastic Deformation **8 hours**

Atomic Structure – Atom binding, Crystal Structure – Body-centered cubic, Face-centered Cubic, Close-packed Hexagonal. Crystallographic planes, Mechanism of crystallization and Crystal Imperfections, Grain size and Grain Size Measurement. Deformation – Slip, Twinning and Fracture.

PHASE DIAGRAMS **8 hours**

Solid solutions - Hume Rothery's rules – the phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphous systems - the tie-line rule - the lever rule - application to isomorphous system - eutectic phase diagram - peritectic phase diagram - other invariant reactions – free energy composition curves for binary systems - microstructural change during cooling.

FAILURES OF METALS **8 hours**

Fracture mechanisms -Griffith's theory - stress intensity factor, Ductile and brittle Fracture, Ductile to brittle transition, significance and fracture toughness- Environment sensitive fracture, Fatigue –Cyclic stress, S-N curve, crack initiation and propagation mechanisms, factors affecting fatigue life, Environment effects on fatigue, high temperature fracture – creep, procedure of failure analysis

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FERROUS ALLOYS **8 hours**

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructure of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - diffusion in solids - Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel – pearlitic, baintic and martensitic transformations - tempering of martensite – steels – stainless steels – cast irons.

ADVANCED MATERIALS **8 hours**

Properties and applications of dual phase steels, high strength low alloy steel, Maraging steel, Special purpose steels – introduction to smart materials, engineering plastics and composites materials – properties and applications of ceramics – WC, TiC, TaC, CBN – types and applications of nanomaterials.

Reference

1. Balasubramaniam, R. "Callister's Materials Science and Engineering". Wiley India Pvt. Ltd., 2014.

2. Raghavan, V. "Physical Metallurgy: Principles and Practice". PHI Learning, 2015.

3. Raghavan, V. "Materials Science and Engineering: A First course". PHI Learning, 2015.

4. Donald R Askeland, Wendelin J Wright, "Essentials of Materials Science and Engineering", Cengage Learning, 2013.

5. Smith, W.F., Hashemi, J. & Prakash, R. "Materials Science and Engineering". Tata McGraw Hill Education Pvt. Ltd., 2014.

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U18MEP6006 TECHNICAL SEMINAR AND PUBLICATION

L	T	P	J	C
0	0	0	2	1

CO1: Understand the importance of paper publication as an essential part of research.

CO2: Analyze topic of professional interest.

CO3: Identify and analyze an engineering problem and perform literature survey.

CO4: Formulate the work plan for solving the complex engineering problem.

CO5: Prepare own report and check for plagiarism.

CO6: Create high quality research paper and publish in reputed journals and conference.

OBJECTIVES:

To provide essential knowledge and skills required for writing, presenting and publish the technical papers.

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1							S							
CO2				S										
CO3		S		M										
CO4		S												
CO5					S									
CO6					S									

Course Assessment methods

Direct
1. Review / viva 2. Report Preparation 3. Journal paper preparation 4. Publication
Indirect
1. Course-end survey

1. Students shall identify a current topic in his/ her branch of engineering and get approval from the concerned faculty.
2. Form a team not exceeding three students.
3. Identify a project supervisor based on specialization.
4. Collect sufficient literature on the topic and prepare your own report.
5. Work to be completed
   a. Literature survey
   b. Formulation of objective
   c. Formulation of design and methodology
   d. Formulation of work plan
   e. Preparation of journal paper

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f. Publication of paper in conference/ Scopus index journal

6. **Rubrics for Evaluation**
    a. Technical Seminar Reviews
    b. Paper publication

Approved by BoS Chairman

VII Semester

Approved by BoS Chairman

U18MET7001 **ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT**

L	T	P	J	C
3	0	0	0	3

Course outcomes
After successful of the course, the student would be able to:

CO1: Evaluate the economic theories, cost concepts and pricing policies
CO2: Analyze the market structures and integration concepts
CO3: Apply the concepts of national income and understand the functions of banks and concepts of globalization
CO4: Apply the concepts of financial management for project appraisal and working capital management
CO5: Understand accounting systems
CO6: Analyse financial statements using ratio analysis

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M				M		M			M			M
CO2				M		M		S			M			M
CO3						M		S			M			M
CO4				M				M			S			M
CO5								S			S			M
CO6		M		M				S			S			M

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

ECONOMICS, COST AND PRICING CONCEPTS **9 hours**

Economic theories – Demand analysis – Determinants of demand – Demand forecasting – Supply – Actual Cost and opportunity Cost – Incremental Cost and sunk Cost – Fixed and variable Cost – Marginal Costing – Total Cost – Elements of Cost – Cost curves – Breakeven point and breakeven chart – Limitations of break- even chart – Interpretation of break-even chart – Contribution – P/V-ratio, profit- volume ratio or relationship – Price fixation – Pricing policies – Pricing methods.

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CONCEPTS ON FIRMS AND MANUFACTURING PRACTICES 9 hours

Firm – Industry – Market – Market structure – Diversification – Vertical integration – Merger – Horizontal integration.

NATIONAL INCOME, MONEY AND BANKING, ECONOMIC 9 hours

ENVIRONMENT

National income concepts – GNP – NNP – Methods of measuring national income – Inflation – Deflation – Kinds of money – Value of money – Functions of bank – Types of bank – Economic liberalization – Privatization – Globalization

CONCEPTS OF FINANCIAL MANAGEMENT 9 hours

Financial management – Scope – Objectives – Time value of money – Methods of appraising project profitability – Sources of finance – Working capital and management of working capital

ACCOUNTING SYSTEM, STATEMENT AND FINANCIAL ANALYSIS 9 hours

Accounting system – Systems of book-keeping – Journal – Ledger – Trail balance – Financial statements – Ratio analysis – Types of ratios – Significance – Limitations

Theory :45 hours **Total: 45 hours**

References:

1. Prasanna Chandra, "Financial Management (Theory & Practice)",Tata Mcgraw Hill Publishing Co Ltd, 2016.
2. Weston & Brigham, "Essentials of Managerial Finance", The Dryden Press; Fifth Edition edition (1974)
3. Pandey, I. M., "Financial Management"
4. Fundamentals of Financial Management- James C. Van Horne.
5. Bhaskar S. "Engineering Economics and Financial Accounting", (2003) Anuradha Agencies, Chennai
6. Financial Management & Policy -James C. Van Horne
7. Management Accounting & Financial Management- M. Y. Khan & P. K. Jain
8. Management Accounting Principles & Practice -P. Saravanavel
9. Ramachandra Aryasri.A., and Ramana Murthy V.V.,"Engineering Economics & Financial Accounting"-Tata McGraw Hill, New Delhi, 2006.
10. Varshney R.L., and MaheswariK.L.,"Managerial Economics" – Sultan Chand & Sons, New Delhi, 2001.
11. Samvelson and Nordhaus,"Economics"-Tata McGraw Hill, New Delhi, 2002

Approved by BoS Chairman

U18MET7002 POWER PLANT ENGINEERING **L T P J C**

3 0 0 0 3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Illustrate the various circuits in steam power plant and working principle of boilers.
CO 2: Discuss the working of combustion equipment's, condensers, and cooling towers**.**
CO 3: Summarize the various nuclear reactors and waste disposal methods.
CO 4: Outline the steps involved in site selection and working principle of hydroelectric power plants.
CO 5: Explain the working of renewable power plants.
CO 6: Estimate the power plant load factor and utilization factor.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) - Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					M	W		M	M			M	
CO2	M					W			M	M			M	
CO3	M					M	M		M	M			M	
CO4	M						W		M	M			M	
CO5	M								M	M			M	
CO6	M					W			M	M	W		M	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

STEAM POWER PLANT AND COMPONENTS 9 Hours

Steam generators-types, forced circulation, high-pressure boilers and super critical boilers, fluidized bed boiler, boiler accessories and mountings, Draft- forced, induced and balanced drafts, Heat recovery equipment - Economisers, air preheaters and reheaters, different types of superheaters and de-superheaters, Boiler testing, Development of a process flow diagram, heat and mass balance of the components of a process flow diagram

COMBUSTION EQUIPMENTS, CONDENSERS AND COOLING TOWERS 9 Hours

Combustion equipments- Types of combustion, stokers, fuel and ash handling equipments. Selection of fans. Emission control, flue gas cleaning, particulate and gaseous emission control methods. Condensers and Cooling towers- Different types, design factors, air removal, performance calculation. Cooling towers- natural and mechanical draft types.

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NUCLEAR AND HYDEL POWER PLANTS **9 Hours**

Nuclear energy-General nuclear fuels used in reactors, elements of nuclear reactor, moderator, control rods, coolants, description of different types of reactors. Radiation hazards, radioactive waste disposal. Hydroelectric power plant- - Runoff river plants, pumped storage plants, underground stations, hydel plant axillaries and plant operation.

RENEWABLE ENERGY SOURCES **9 Hours**

Concentrating collectors, photovoltaic cell. Horizontal and vertical types of wind turbines. Other plants: Geothermal plants, tidal power plant, biomass and biogas plants, and OTEC plants

POWER PLANT ECONOMICS **9 Hours**

Plant load factor and utilization factor, cost economics – tariff rates, demand changes, load distributions. Energy conversion and audit.

Theory :45 Hours **Total: 45 Hours**

REFERENCES:

1. EI- Wakil M.M, “Power Plant Technology”, Tata McGraw-Hill, 2001.
2. Arora S.C and Domkundwar S, “A course in Power Plant Engineering”, Dhanpatrai, 2001.
3. Nagpal, G.R. “Power Plant Engineering”, Kanna Publishers, 2008.
4. Rai, G.D. “Introduction to Power Plant Technology”, Khanna Publishers, 2009.
5. Nag P.K, “Power plant Engineering”, Tata McGraw-Hill, 2008

Approved by BoS Chairman

U18MET7003 DIGITAL MANUFACTURING

L	T	P	J	C
3	0	0	0	3

Course Outcomes

CO 1: Illustrate the Digital Manufacturing techniques with suitable applications.
CO 2: Explain features of Digital Factory and PLM concepts.
CO 3: Summarize the various features of IoT concepts.
CO 4: Explain Industry 4.0 standards with relevance to industrial context.
CO 5: Explain the intelligent systems in the Manufacturing environment.
CO 6: Explain the IoT applications in the Industrial Environment .
Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) - Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M		M										
CO2	S													
CO3	S			S			M							
CO4	S													
CO5	S			S			M							
CO6		M												

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION TO DIGITAL MANUFACTURING **9 hours**

Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System. Design process and role of CAD, Types and applications of design models. Component modeling, Machine and tool selection, Defining process and parameters, Tool path generation, Simulation, Post processing. : Introduction, Principle, Thermo jet printer, Sander's model market, 3-D printer, Genisys Xs printer, JP system 5, object quadra system-Rapid proto typing.

DIGITAL FACTORY AND PRODUCT LIFE CYCLE MANAGEMENT **9 hours**

Introduction, Scope, Methods and Tools Used in Virtual Manufacturing, Benefits. Virtual factory simulation. Introduction, Types of Product Data, PLM systems, Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

INTERNET OF THINGS **9 hours**

Introduction, Applications, IoT data management requirements, Architecture of IoT, Technological challenges, RFID and the Electronic Product Code (EPC) network, The web of things, Issues in implementing IoT.

INDUSTRY 4.0 **9 hours**

Definition of Industry 4.0, Comparison of Industry 4.0 Factory and today's Factory. Cybernetics as the scientific basis of cyber-physical models. Cybersecurity in Industry 4.0. Virtual models of process control. The application of robotics in the I4.0. Industrial internet of things. Intelligent process control and intelligent diagnostics. Cyber-Physical Systems, Cloud Computing / Cloud Manufacturing. BLOCK Chain- Value chains in manufacturing companies.

INDUSTRIAL IOT- APPLICATION **9 hours**

Application Domains: Factories and Assembly Line, Food Industry. Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. Oil, chemical and pharmaceutical industry.

Theory: 45 hours **Total: 45 hours**

Reference

1. “Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress)

2. “Industrial Internet of Things: Cyber manufacturing Systems” by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)

3. Klaus Schwab 2016: The Fourth Industrial Revolution,

https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab

4. Gerard Jounghyun Kim, “Designing Virtual Systems: The Structured Approach”, Springer, 2005.

5. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer, 2004.

6. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013.

Approved by BoS Chairman

U18MEP7703 Mini Project / Phase I Project

L	T	P	J	C
0	0	0	6	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Identify a mechanical engineering problem from the society.

CO 2: Conduct systematic investigations, apply tools and develop solutions.

CO 3: Demonstrate awareness of safety, professional ethics, and concerns for environment and society.

CO 4: Communicate effectively through oral means and documentations.

CO 5: Manage projects with considerations of time and finance.

CO 6: Develop a team and contribute as a member and or as a leader.

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	S		S								S	S	S
CO2	S		S	S	S							S	S	S
CO3						S	S	S				S		
CO4									S	S				
CO5											S	S		
CO6									S	S				

- The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design, manufacture of a device, experimentation, simulation of systems.
- The work can be an innovative improvement of existing system and shall include modelling, design, experimentation, evaluation, fabrication and or analysis.
- Suitable methodology to be arrived by evaluating existing solutions. Suitable modern tools shall be used to find the solution.
- Every project work shall have a guide who is a faculty member of the of the institution.
- For industrial projects, supervisor from the organization will be a co-guide.
- Each project work will be carried out by a batch of maximum three students.

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- The project period allotted shall be utilized by the students to receive directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and to present periodical seminars on the progress made in the project.
- Continuous assessment shall be made as prescribed in the regulations.
- Progress of the project will be evaluated based on a minimum of three reviews.
- Review committee will be constituted by the Head of Department.
- Each student shall finally submit a report covering background information, literature survey, problem statement, methodology and use of modern tools within the stipulated date.
- Phase I Project students will extend and/or complete their work during the next semester as Phase II Project. However, they should complete a considerable part of their work during Phase I.

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VIII semester

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U18MET8001 ENTREPRENEURSHIP DEVELOPMENT

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Identify the role of Entrepreneurship and study factors affecting entrepreneurial growth.

CO 2: Apply motivational techniques for effective stress management in entrepreneurship development.

CO 3: Identify ownership structures for better project formulation and business growth.

CO 4: Apply appropriate corrective measures after categorizing causes of industrial sickness.

CO 5: Apply knowledge on sources of finance for managing working capital.

CO 6: Apply break even analysis and network analysis in costing management.

Pre-requisite: Nil

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			M			M	M	M		M	M			S
CO2						M		S		M	M			S
CO3							S	M		S	M			M
CO4						M		S		W				
CO5								M			S			M
CO6			W			W		S			S			S

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

ENTREPRENEURSHIP AND ECONOMIC DEVELOPMENT **8 hours**

Entrepreneur – Evolution – Characteristics of entrepreneur – Functions of entrepreneur – Differences between entrepreneur and manager – Differences between entrepreneur and intrapreneur - Types of entrepreneur –Contribution of Entrepreneurship to Economic Growth of Country –Economic and Non-economic factors affecting entrepreneurial growth.

MOTIVATION **8 hours**

Definition – Nature of Motivation – Internal and External factors affecting Motivation - Training for Achievement - Kakinada experiment, Thematic appreciation test, Self-rating, Business game – Stress Management – Symptoms and causes of stress – Psychosomatic, psychological, Behavioral problems – Coping with stress.

GROWTH STRATEGIES IN BUSINESS **8 hours**

Outline of role of enterprises – Ownership structure – Sole proprietorship, Partnership – Project formulation – Significance, Contents of a project - Objectives of business growth – Stages of growth – Internal growth

strategies – Expansion, Diversification - External growth strategies – Franchising – Joint Ventures – Acquisition – Mergers and Subcontracting.

INDUSTRIAL SICKNESS **7 hours**

Process of Industrial sickness – Signals and symptoms – Causes and consequences – corrective measures – Government policies – IPR 1948, IPR 1956, IPR 1977, IPR1980, IPR 1990.

FINANCING AND ACCOUNTING **7 hours**

Need for financing- Differences between Fixed capital and working capital – Sources of finance Term loans – Financial institutions – Management of working capital- Gross working capital, Net working capital – Types of working capital – Factors determining working capital.

COSTING **7 hours**

Definition – Methods of costing – Classification of costs – Elements of costs –Breakeven point analysis - Network analysis - PERT/CPM – Taxation – Income Tax – Sales Tax – Excise duties.

Theory: 45 hours **Total: 45 hours**

TEXTBOOKS:

1. Khanka. S.S., "Entrepreneurial Development" S. Chand & Co. Ltd., Ram Nagar, New Delhi, 2019.
2. Donald F Kuratko, "Entrepreneurship – Theory, Process and Practice", 9th Edition, Cengage Learning 2018.

REFERENCES:

1. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2019.
2. Mathew J Manimala, "Entrepreneurship theory at crossroads: paradigms and praxis" 2nd Edition Dream tech, 2018.
3. EDII "Faulty and External Experts – A Handbook for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 2018.
4. Dr. R. Radhakrishnan and Dr. S. Balasubramanian, "Intellectual Property Rights", Excel Books,2018.

C. Velmurugan

Approved by BoS Chairman

U18MEP8702	Capstone Project / Internship / Phase II project

L	T	P	J	C
0	0	0	20	10

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Identify an engineering problem from the society.

CO 2: Conduct systematic investigations, apply tools and develop solutions.

CO 3: Demonstrate awareness of safety, professional ethics, and concerns for environment and society.

CO 4: Communicate effectively through oral means and documentations.

CO 5: Manage projects with considerations of time and finances.

CO 6: Develop a team and contribute as a member and or as a leader.

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S		S								S	S	S
CO2	S		S	S	S							S	S	S
CO3						S	S	S				S		
CO4									S	S				
CO5											S	S		
CO6									S	S				

- Phase II Project students should complete their work started in Phase I (Create a model/ fabricate a model/conduct experiments/simulate mechanical system/implement improved ideas for the project work carried in Phase-I)
- Capstone Project students should work on new projects and complete them.
- Internship is permitted for opting students who have received offers through the institution Placement Cell, with the approval of Project Coordinator and HoD,
- Continuous assessment shall be made as prescribed in the regulations.
- Progress in the course will be evaluated based on a minimum of three reviews.
- Review committee will be constituted by the Head of Department.
- Each student shall finally submit a comprehensive report on the work carried out as per the required format within the stipulated time.

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Programme Electives

Design Engineering

U18MEE0001	Design of Jigs, Fixtures and Press Tools	L	T	P	J	C
	(Use of P S G Design Data Book is permitted in the University examination)	3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO1: Summarize the different methods of Locating Jigs and Fixtures and Clamping principles

CO2: Design and develop jigs and fixtures for given component

CO3: Discuss the press working terminologies and elements of cutting dies

CO4: Distinguish between Bending and Drawing dies.

CO5: Discuss the different types of forming techniques

CO6: Discuss the computer aids for the design of sheet metal dies

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M						M		M	M			M	
CO2	M								M	M			M	
CO3	M								M	M			M	
CO4	M								M	M			M	
CO5	W								M	M			M	
CO6	M					W	W		M	M			M	

LOCATING AND CLAMPING PRINCIPLES **9 hours**

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

JIGS AND FIXTURES **9 hours**

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES **9 hours**

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

BENDING AND DRAWING DIES **9 hours**

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

FORMING TECHNIQUES AND EVALUATION **9 hours**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

TOTAL: 45 hours

REFERENCES:

1. ASTME Fundamentals of Tool Design Prentice Hall of India.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Donaldson, Lecain and Goold "Tool Design", 5th Edition, Tata McGraw Hill, 2017.
4. Hoffman "Jigs and Fixture Design", Thomson Delmar Learning, Singapore, 2004.
5. Kempster, "Jigs and Fixture Design", Third Edition, Hoddes and Stoughton, 1974.
6. Venkataraman. K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005
7. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
8. Joshi P.H "Press tools - Design and Construction", wheels publishing, 1996

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U18MEE0002 Vibration and Noise Control

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Develop the mathematical models for vibrating systems.
CO 2: Solve problems in vibrating systems with single degree of freedom.
CO 3: Explain two degree of freedom vibrating systems and solve simple problems.
CO 4: Examine the multi degree of freedom systems.
CO 5: Make use of proper instruments for vibration measurement.
CO 6: Explain about engineering noise and control.

Pre-requisite:

1. U18MET4003 Kinematics of Machinery
2. U18MEI5205 Dynamics of Machinery

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M							W				M	
CO2	M	M		M					W				M	
CO3	M	M		M					W				M	
CO4	M	M		M					W				M	
CO5	M	M		M					W				M	
CO6	M	M		M					W				M	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

FUNDAMENTALS OF VIBRATION **9 hours**

Introduction -Sources of vibration-Mathematical Models-Types of vibration. Review of Single degree freedom systems with and without damping –Types of Damping- Dynamics of rotating and reciprocating engines– Critical speed of industrial rotors with specific reference to rigid and flexible rotors – Influence of type of bearings – Vibration isolation – Nonmetallic isolators.

TWO DEGREE FREEDOM SYSTEM **9 hours**

Introduction- Free vibration of Undamped and damped system. Torsional system-Spring coupled system – mass coupled system – Vibration of two-degree freedom system – Forced vibration with harmonic Excitation – Dynamic

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Vibration Absorber – Torsional Vibration Absorber-Vibration control.

MULTI-DEGREE FREEDOM SYSTEM 9 hours

Longitudinal, Transverse, Torsional systems, Geared systems Complexities – Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigen vectors – Orthogonal properties – Energy methods of Rayleigh, Ritz and Drunkenly

EXPERIMENTAL VIBRATION ANALYSIS 9 hours

Need for the experimental methods in Vibration analysis. Vibration Measuring Devices: seismometer, accelerometer and velometers-Vibration exciters: mechanical, hydraulic, electromagnetic and electrodynamic –Frequency measuring instruments: single reed, multi reed and stroboscope. Vibration meters and sound level meter. Signal conditioning devices: Filters, Amplifiers, Modulators/Demodulators, ADC/DAC. Signal analysis devices. Vibration recording and display devices. Experimental modal analysis. System Identification from frequency response

ENGINEERING NOISE AND ITS CONTROL 9 hours

Introduction-Sound Power, Sound Intensity and Sound pressure level. Sound spectra. The decibel scale-Decibel addition, subtraction and averaging- Loudness, Weighting networks, Equivalent sound level. Noise: Effects, Ratings and Regulations. Noise: Sources, Isolation and control-Industrial noise sources-Industrial noise control strategies-Noise control at the source, along the path and at the receiver.

Theory :45 hours Total :45hours

REFERENCES:

1. Ambekar.A.G. “Mechanical Vibrations and Noise Engineering”, Prentice Hall of India, New Delhi, 2006
2. Thomson, W.T, “Theory of Vibration with Applications”, Nelson Thomas Ltd,1998.
3. Rao, S.S.,” Mechanical Vibrations,” Printice hall,2011.
4. Den Hartog, J.P, “Mechanical Vibrations,” Read books, 2008.
5. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa, New Delhi, 2000.
6. William.w.Seto, “Theory and problems of Mechanical Vibrations,”Schaum Outline Series, Mc Graw Hill Inc., Newyork,1990.

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U18MEE0003 Composite Materials

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Explain role of matrices and reinforcements, different types of fibers, Applications of composites.

CO 2: Discus the production and applications of metal matrix composites.

CO 3: Enumerate the various methods for producing ceramic matrix composites.

CO 4: Sketch and explain the polymer resin composite fabrication methods.

CO 5: Describe the various composite testing.

CO 6: Select an appropriate manufacturing technique for composite materials.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M					S						W	
CO2	S	M					M	W		M			M	
CO3	M	M										M	W	
CO4	M							W				M	W	
CO5	M									W		M	W	
CO6	S						S	W						S

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION TO COMPOSITES **10 hours**

Fundamentals of composites - need for composites – Enhancement of properties - classification of composites – Functions and selection of matrix and reinforcement materials – Particle reinforced composites-Fiber reinforced composites- Rule of mixtures- Applications of various types of composites- Introduction to nano materials – Types of fibers, Clay fibers, Aramid fibers, Metal fibers, Alumina fibers, Borax fibers, Silicon carbide fibers, Multiphase fibers, Whiskers, flakes etc.

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METAL MATRIX COMPOSITES **9 hours**

Metal Matrix, Reinforcements – particles – fibres, Effect of reinforcement - Volume fraction. Various types of Metal Matrix Composites, Characteristics of MMC, Alloy vs. MMC, Advantages and limitations of MMC –Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

CERAMIC MATRIX COMPOSITES **9 hours**

Engineering ceramic materials – Properties – Advantages – Limitations – Monolithic ceramics - Need for CMCs – Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics – Non oxide Ceramics – Aluminium oxide – Silicon nitride – Reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing).

POLYMER MATRIX COMPOSITES **9 hours**

Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non-woven random mats – Various types of fibres. Methods for producing PMC - Hand layup processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre Reinforced Plastics (FRP), Glass fibre Reinforced Plastics (GRP).

TESTING OF COMPOSITES **8 Hours**

Mechanical testing of composite – tensile testing – compressive testing-infra laminar shear testing, infra laminar shear testing, fracture testing.

Theory : 45 hours **Total : 45 hours**

REFERENCES:

1. Mathews F.L. and Rawlings R.D., “Composite materials: Engineering and Science”, Chapman and Hall, London, England, 2006.
2. Chawla K.K., “Composite materials”,Springer –Verlag, 2012.
3. Clyne T.W. and Withers P.J., “Introduction to Metal Matrix Composites”, Cambridge University Press, 2003.
4. Strong A.B., “Fundamentals of Composite Manufacturing”, SME, 2008.
5. Sharma S.C., “Composite materials”, Narosa Publications, 2004.
6. “Short Term Course on Advances in Composite Materials, Composite Technology Centre, Department of Metallurgy”, IIT- Madras, December 2001.
7. Autar.K.Kaw, “Mechanics of Composite Materials”, CRC Press, 2006.

Approved by BoS Chairman

U18MEE0004 Design for Manufacturin g and Environment

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Understand the basics of DFM.

CO 2: Outline the factors of material and casting influencing form design.

CO 3: Demonstrate machining and casting considerations in component design.

CO 4: Understand and demonstrate the environmental considerations and assessment methods. **CO 5:** Design a component with environmental considerations.

CO 6: Apply the DFM Concepts.

Pre-requisite: 1. U15MET304 -Manufacturing Technology-I
2.U15MET403 – Manufacturing Technology - II

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	S				M		M					M
CO2	M	M	S				M		M					M
CO3	M	M	S				M		M					M
CO4	M	M	S				M		M					M
CO5	M	M	S				S		M					M
CO6	M	M	S				M		M					M

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION **8 hours**

Process selection evaluation method. process capability and process capability metrics – General design principles of manufacturability – Material selection – Strength and Mechanical factors- geometric tolerances, surface finish, cumulative effect of tolerances - Worst case method, Root sum square method.

Approved by BoS Chairman

FACTORS INFLUENCING FORM DESIGN **8 hours**

Working principle, Material, Manufacture, Design-, Production method, size, surface property Influence of materials on form design - castings, aluminium casting, pressure die casting, Plastic molding, form design of welded members

COMPONENT DESIGN – MACHINING AND CASTING CONSIDERATION

8 hours

Design features to facilitate machining –Twist drill –Drill entry and run out counter sunk head screws-Redesign of casting based on parting line consideration-pattern, mould, parting line, cast holes-cored holes, machined holes, identify the possible and probable parting line.

DESIGN FOR THE ENVIRONMENT **16 hours**

Introduction to Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – 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.

CASE STUDIES **5 hours**

Application concepts of design for manufacture in real time conditions- Exposure on DFM software.

Theory: 45 hours **Total: 45hours**

REFERENCES:

1. James G. Bralla,"Design for Manufacturability handbook", McGraw Hill Book Co.,1998, Second edition.
2. Harry Peck,"Design for manufacture", Pitman Publishers., 1973.
3. R.Matousek "Engineering Design", Blackie & sons, 1974.
4. Design for environment, Joseph Fiksel, Mcgraw – Hill companies, Inc, 1996.
5. Graedal T.Allen. By.B.Design for the environment, Angel wood Clift, Prelude hall, reason Pub 1996.

Approved by BoS Chairman

U18MEE0004 **TRIBOLOGY**

L	T	P	J	C
3	0	0	0	3

CO 1: Understand the fundamentals of tribology and its significance

CO2: Measure friction and identify the friction mechanism

CO 3: Apply the principles of wear in minimizing it

CO 4: Gain knowledge in lubrication and select the appropriate lubricant

CO 5: Gain knowledge in adhesion and select bearing materials

CO 6: Apply the principles of surface engineering to improve the tribological properties of surfaces.

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	W						M						M	
CO2	S						M						M	
CO3	S						M						M	
CO4	M						M						M	
CO5	M						M						M	
CO6	M						M						M	

Introduction 7 hours

Introduction – Tribology in design – Tribology in industry – Economic considerations – Friction, Wear and Lubrication – Nature of surfaces – Contact between surfaces –Bearings – Sliding contact and rolling contact.

Friction 7 hours

Types – Empirical relations – Origin – Measurement – Theories – Other mechanisms – Friction in metals and non-metals.

Wear 7 hours

Types – Factors affecting wear - Theories – Mechanisms – Measurement – Regimes of wear – Wear in metals and non-metals – Approaches to wear reduction.

Lubrication 9 hours

Fundamentals of viscosity – Measurement of viscosity - Effect of temperature, pressure and shear rate on viscosity - Principle and application of hydrostatic, hydrodynamic lubrication, elasto hydrodynamic lubrication, boundary and solid lubrication – Types and properties of lubricants – Speed and load effects on lubrication – lubrication in rolling, drawing and forging.

Approved by BoS Chairman

Adhesion and Bearing Materials 8 hours

Adhesion: Adhesion due to contact, surface tension – Factors influencing adhesion – Stiction

Bearing Materials: Typical bearing materials – Properties – Advantages and disadvantages – Construction of rolling, fluid film lubricated and dry bearings

Surface Engineering 7 hours

Surface Engineering: Introduction – Surface modification – Transformation Hardening, Surface Melting, Thermo chemical Processes – Surface coatings – Plating and Anoding – Fusion Processes, Vapor Phase Processes – Selection of coating – Properties and parameters.

REFERENCES:

5. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.
6. Bhushan, Principles and Applications, John Wiley & Sons, Inc, New York, 2013.
7. Gwidon W. Stachowiak & Andrew W. Batchelor, Engineering Tribology, Butterworth-Heinemann, 2016.
8. Gwidon W. Stachowiak, Wear-Materials Mechanisms & Practice, John Wiley & Sons, 2006.
9. Majumdar (B C), Introduction to Tribology of Bearings, S. Chand & Company, 2008.

Approved by BoS Chairman

Programme Electives

Thermal Engineering

Approved by BoS Chairman

U18MEE0006 REFRIGERATION AND AIRCONDITIONING

(Use of Psychrometric chart and Refrigeration Table is permitted.)

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Explain the working of various refrigeration systems and System components.
CO 2: Estimate the performance of VCR system and illustrate the working of different VCR systems.
CO 3: Explain the working principle of different VAR systems estimate the COP of VAR systems and estimate the performance of the system.
CO 4: Illustrate the various non-conventional refrigeration methods.
CO 5: Explain the various air conditioning system components and classify the air conditioning system.
CO 6: Estimate the cooling load for various conditions considering the different heat sources.

Pre-requisite: U18MEI5201 Thermal Engineering
U18MET3004 Engineering Thermodynamics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W			W			M	
CO2	S	S					W			W			S	
CO3	S	S					W			W			S	
CO4	S									W			M	
CO5	S									W			M	
CO6	S	M								M			S	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION TO REFRIGERATION **9 hours**

Refrigeration and second law of thermodynamics-Engine, refrigerator and heat pump-Methods of Refrigeration- Evaporative refrigeration, Refrigeration by expansion of air, Refrigeration by throttling of gas, Ice refrigeration, Steam jet refrigeration, Dry ice refrigeration, Refrigeration by using liquid gases- Refrigerants- Properties & selection-Environmental impact of refrigerants- System components- Compressors Evaporators-Condensers- Thermostatic Expansion devices- Cooling towers.

VAPOUR COMPRESSOR REFRIGERATION SYSTEM **9 hours**

Simple vapour compression refrigeration cycle- T-S, and p-h charts for VCR system- presentation of different process on p-h chart- COP from T-S chart- Advantages and Disadvantages of VCR over air compression refrigeration- Methods for improving COP – Single load and multi load systems. Methods for Defrosting- Air refrigeration – Bell Coleman Air refrigerator – Simple cooling & Simple evaporative type – Boot strap & Boot strap evaporative type. air refrigeration- Bell Coleman Air refrigerator- Simple cooling and simple evaporative type- Boot strap and boot strap evaporative type.

ABSORPTION REFRIGERATION SYSTEM **9 hours**

Introduction- Basic absorption system- Actual ammonia absorption system- Lithium Bromide absorption refrigeration system- Electrolux refrigerator – Actual Electrolux refrigerator- COP of absorption refrigeration system.

Non-conventional refrigeration – Vortex tube – Thermo Electric refrigeration- Pulse tube refrigeration- Cooling by adiabatic demagnetization.

AIRCONDITIONING SYSTEM **9 hours**

Methods of air conditioning – Direct expansion- All water systems- All air systems- Combined systems- Heat pump systems- Air conditioning equipments – Air filters – Humidifiers- Dehumidifiers- fans and blowers- cooling towers and spray ponds- Air distribution system. Types of air conditioners- Window, split type and central air conditioning – Applications- Automotive air conditioning.

COOLING LOAD CALCULATIONS **9 hours**

Different heat sources- Types of load- Conduction heat load, radiation heat load, radiation load of sun, Occupants load, Equipment load, Infiltration load, Fresh air load- Bypass factor- Effective room sensible heat factor- Design of space cooling load. Basics of Air duct design. Heat pump – Types-Working fluids for heat pumps- Heat pump circuit- Performance of Heat pump.

Theory: 45 hours **Total: 45 hours**

REFERENCES:

1. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International (P) Ltd, 2015.
2. Arora. C.P., "Refrigeration and Air Conditioning", Tata McGraw-Hill New Delhi,2007.

Approved by BoS Chairman

3. Roy.JDossat, “Principles of Refrigeration”, Prentice Hall, 2001
4. Stoecker N.F and Jones, "Refrigeration and Air Conditioning", MCG raw Hill Education, Asia,2001.
5. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International (P) Ltd, 2013.

Approved by BoS Chairman

U18MEE0007	**Computational Fluid Dynamics**	**L**	**T**	**P**	**J**	**C**
	(Use of Psychrometric chart and Refrigeration Table is permitted.)	**3**	**0**	**0**	**0**	**3**

Course outcomes
After successful completion of the course, the student would be able to

CO 1: Understand the governing equations of fluid dynamics and boundary conditions

CO 2: Understand the Discretization techniques

CO 3: Apply the knowledge of finite difference discretization methods for solving one dimensional heat conduction equation

CO 4: Apply finite volume techniques for different schemes for solving one dimensional heat conduction equation.

CO 5: Understand various grid generation methods.

Pre-requisite: U18MEI4202 Fluid Mechanics and Machinery
U18MEI6201 Heat and Mass Transfer.

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M							M	M		M	M	
CO2	S	M							M	M			M	
CO3	M	M							M	M			M	
CO4	S	M							M	M		M	M	
CO5	M	M							M	M		M	M	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. Tutorial 6. End semester exam	Course end survey

INTRODUCTION AND GOVERNING EQUATIONS **9 hours**

Introduction - Impact and applications of CFD in diverse fields - Governing equations of fluid dynamics – Continuity - Momentum and energy - Generic integral form for governing equations - Initial and Boundary conditions - Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance.

C. Velmurugan
Approved by BoS Chairman

DISCRETIZATION BASIC ASPECTS OF DISCRETIZATION 10 hours

Discretization techniques – Introduction to Finite difference - Finite volume method – central, forward and backward difference expression for uniform grid-central difference expression for Non-uniform grid- Difference equations - Numerical Error- Grid independence test.

FINITE DIFFERENCE METHODS FOR CONDUCTION HEAT TRANSFER 10 hours

One–dimensional and two-dimensional steady state heat conduction-Transient one-dimensional heat conduction –Methods of solutions- Explicit - Implicit - Crank-Nicolson– Stability criterion.

FINITE VOLUME METHODS FOR CONVECTION – DIFFUSION 8 hours

Steady one-dimensional convection and diffusion - Central difference, upwind, quick, exponential, hybrid and power law schemes. Numerical procedure for SIMPLE algorithm.

INTRODUCTION TO GRID GENERATION8 hours

Choice of grid, grid-oriented velocity components, Cartesian velocity components, staggered and collocated arrangements, adaptive grids.

Theory : 45 hours **Total : 45 hours**

REFERENCES:

1. K.A. Hoffman, (2000), Computational Fluid Dynamics for Engineering, Vol I - III Engineering Education System, Austin, Texas.
2. J.D. Anderson, Jr., (2012), Computational Fluid Dynamics – The basics with applications, McGraw-Hill.
3. K. Muralidhar, T. Sundarajan, (2001), Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi.
4. S.V. Patankar, (1999), Numerical Heat Transfer and Fluid Flow, Hemisphere, New York.
5. V.V. Ranade, (2002), Computational Flow Modeling for Chemical Reactor Engineering, Academic Press

U18MEE0008 **Design of Thermal Systems**

L	T	P	J	C
3	0	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO1: To understand various optimization techniques and apply them to thermal design

CO2: To expose mathematical tools for characterization of performance of energy equipment

CO3: To learn basic principles underlying pumping, heat exchangers modeling and optimization in design of thermal systems

CO4: To study modelling methods for thermal equipment's and learn simulation techniques

CO5: To optimization concerning design of thermal systems

CO6: To develop representational modes of real processes and systems

Pre-requisites:

1. U18MET3004 Thermodynamics
2. U18MEI4202 Fluid Mechanics and Machinery
3. U18MEI6201 Heat and Mass Transfer

CO/PO Mapping
(S/M/W indicates strength of correlation) S- Strong, M- Medium, W- Weak.

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M		M							S		M	
CO2	S	W		S	S						M		W	
CO3	S	S	S		M	M			S	M			S	
CO4	S	S	S						S				S	
CO5	M	M	M	S									M	S
CO6	S	S	M	S	S				M				S	M

Course Assessment Methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. Tutorial 6. End Semester exam	Course end survey

Approved by BoS Chairman

DESIGN CONCEPTS **9 hours**

Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor

MATHEMATICAL MODELLING **10hours**

Equation Fitting, Nomography, Empirical Equation, Regression Analysis, Different Modes of Mathematical Models, Selection.

MODELLING THERMAL EQUIPMENTS **11 hours**

Estimation of thermodynamic properties: T-C-P characteristics of binary solutions, Developing T-X diagram, Modelling Heat Exchangers, Evaporators, Condensers, Compressors, and Pumps.

OPTIMIZATION **10 hours**

System simulation: Successive substitution, Newton-Raphson method with one variable. Optimization: Lagrange multiplier, Test for minimum and Maximum,

DYNAMIC BEHAVIOUR OF THERMAL SYSTEM **5 hours**

Steady state Simulation, Laplace Transformation, Feedback Control Loops, Stability Analysis.

Theory: 45 hours **Total Hours: 45 hours**

Reference Books

1. W.F. Stoecker Design of Thermal Systems, 3 rd Edition, McGraw-Hill, 1989.
2. A.Bejan, G.Tsatsaronis and M.Moran ,Thermal Design and Optimization, John Wiley & Sons. 1996.,
3. Kapur J. N., Mathematical Modelling, Wiley Eastern Ltd , New York , 1989
4. Yogesh Jaluria , Design and Optimization of Thermal Systems , CRC Press , 2007.
5. R.F.Boehm Design Analysis of Thermal Systems, John Wiley & Sons, 1987.
6. B.K. Hodge, Analysis and Design of Energy systems, Prentice-Hall Inc, 1988,
7. Rao S. S., Engineering Optimization Theory and Practice, New Age Publishers, 2005

Approved by BoS Chairman

U18MEE0009 **Design of Heat Exchangers**

L	T	P	J	C
3	0	0	0	3

Course Outcomes

After successful completion of the course, the students should be able to

CO1: Discuss the components of heat exchanger

CO2: Analyze the heat exchanger for flow

CO3: Appraise the design aspects of heat exchangers

CO4: Design and develop a solution for compact and plate heat exchanger

CO5: Predict the performance characteristics for shell and tube condensers

CO6: Analyze heat exchanger using LMTD and NTU methods

Pre-requisites:

1. U18MEI6201 Heat and mass transfer

CO/PO Mapping (S/M/W indicates strength of correlation) S- Strong, M- Medium, W- Weak.														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	W						M	M			M	
CO2	M	W	W						M	M			W	
CO3	S	S	M			W			S	S		M	S	
CO4	S	S	M			W			S	S		M	S	
CO5	M	M	M						M	M		M	M	
CO6	S	S	W						M	M			S	

Course Assessment Methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. Tutorial 6. End Semester exam	Course end survey

CONSTRUCTIONAL DETAILS AND HEAT TRANSFER 8 hours

Types – Shell and Tube Heat exchangers- Regenerators and Recuperators- Industrial Applications of Heat exchangers- Temperature Distribution and its Implications- Analysis of Heat Exchanger – LMTD and effective method (€-NTU method), fouling factor.

Approved by BoS Chairman

FLOW ANALYSIS **4 hours**

Tube side pressure drop for circular cross section tubes, pressure drop in tube bundles in cross flow.

DESIGN ASPECTS **13 hours**

Heat exchanger design methodology, Basic logic structure of process heat exchanger design, Rating of the preliminary design of heat exchanger. Baffle type and geometry, TEMA standards, Design of Shell and Tube Heat exchangers (Bell-Delaware Method).

COMPACT AND PLATE HEAT EXCHANGERS **13 hours**

Design of Compact Heat exchangers and Plate Heat Exchangers (Kakac method).

STEAM CONDENSERS **7 hours**

Thermal design of shell and tube condensers (Kakac method)

Note: The fluid for heat exchangers are considered to be air, water, oil. Chemicals are not been considered and S.I units are to be followed.

Theory: 45 hours **Total Hours: 45 hours**

References:

1. SadikKakac, Hongtan Liu and Anchasa Pramuanjaroenkij, Heat Exchangers, selection, Rating and Thermal Design, CRC press, 2002.
2. D.Q Kern, Process Heat Transfer, McGraw-Hill Book Company, Japan, 21st Printing 1983.
3. Taborek, T. Hewitt G.F and Afgan. N, Heat Exchangers, Theory and Practice, McGraw-Hill Book Co. 1980.
4. Ramesh K.. Shah and Dusan P. Sekulic, Fundamentals of Heat Exchanger Design, John Wiley and Sons, 2003.
5. Design Data Handbook for Design of Heat Exchangers – Compiled from Kumaraguru College of Technology, Coimbatore.

Approved by BoS Chairman

U18MEE0010	GAS DYNAMICS AND JET PROPULSION	L	T	P	J	C
	(Use of approved gas tables is permitted in the examination)	3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Explain the effect of Mach Number on compressibility.

CO 2: Solve the area ratio for nozzle and diffuser for subsonic and supersonic flow conditions.

CO 3: Solve the problems in Rayleigh and Fanno flow for constant area sections.

CO 4: Explain the concept of normal shock for an isentropic flow.

CO 5: Discuss the performance of turbo jet, ram jet and pulse jet engines.

CO 6: Calculate the performance of rocket propulsion systems.

Pre-requisite:

1. U18MEI4202 Fluid Mechanics and Machinery
2. U18MET3003 Engineering Thermodynamics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M							M	M			S	
CO2	S	M							M	M			S	
CO3	S	M							M	M			S	
CO4	S	M		W					M	M			S	
CO5	M	M							M	M			M	
CO6	M	M							M	M			M	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. Tutorial 6. End semester exam	Course end survey

COMPRESSIBLE FLOW – FUNDAMENTALS **9 hours**

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility- Use of Gas tables.

Approved by BoS Chairman

FLOW THROUGH VARIABLE AREA DUCTS **9 hours**

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles- Phenomenon of chocking

FLOW THROUGH CONSTANT AREA DUCTS **9hours**

Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length.

Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer- Applications.

NORMAL SHOCK **9hours**

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl – Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock- Use of tables and charts.

PROPULSION **9 hours**

Aircraft propulsion – types of jet engines – study of turbojet engine components – diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines – thrust, thrust power, propulsive and overall efficiencies

Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants.

Theory : 45 hours **Total : 45hours**

REFERENCES:

1. Yahya. S.M., “Fundamental of compressible flow with Aircraft and Rocket propulsion”, New Age International (p) Ltd., New Delhi, 2009.
2. Patrich.H. Oosthvizen, William E. Carscallen, “Compressible fluid flow”, McGraw-Hill, 2006.
3. Cohen.H., Rogers R.E.C and Sravanamutoo, “Gas turbine theory”, Addison Wesley Ltd., 2005.
4. Ganesan. V., “Gas Turbines”, Tata McGraw-Hill, New Delhi, 2003
5. Rathakrishnan. E., “Gas Dynamics”, Prentice Hall of India, New Delhi, 2001.
6. Babu.V. “Fundamentals of Gas Dynamics”, ANE Books India, 2008.
7. Somasundaram Pr.S.L,“Gas Dynamics and Jet Propulsions” New age International Publishers, 1996.

U18MEE0011 AUTOMOBILE ENGINEERING

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Explain the vehicle structures, lubrication, cooling and emission control systems.

CO 2: Summarize the various fuel injection, ignition and electrical systems of an automobile.

CO 3: Describe the working principle of various components in transmission systems.

CO 4: Discuss the various steering mechanisms and suspension systems.

CO 5: Compare the conventional and antilock braking systems.

CO 6: Discuss the usage of various alternate energy sources in automobiles.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M						M		M	M			M	
CO2	M								M	M			M	
CO3	M								M	M			M	
CO4	M								M	M			M	
CO5	W								M	M			M	
CO6	M					W	W		M	M			M	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

VEHICLE STRUCTURE AND ENGINES **9 hours**

Types of Automobiles - Vehicle Construction – Chassis – Frame and Body – Aerodynamic forces. Engine components, Materials and functions - Cooling and Lubrication systems in engines – Turbo Chargers – Engine Emission Control by three-way Catalytic converter – Electronic Engine Management System.

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ENGINE AUXILIARY SYSTEMS **9 hours**

Carburetor–working principle - Electronic fuel injection system – Mono-point and Multi - Point Injection Systems – Construction, Operation and Maintenance of Lead Acid Battery - Electrical systems – Battery generator – Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type) - Regulators-cut outs.

TRANSMISSION SYSTEMS **10 hours**

Clutch – Types and Construction – Gear Boxes, Manual and Automatic – Floor Mounted Shift Mechanism – Over Drives – Fluid flywheel - Torque converters– Propeller shaft – Slip Joint – Universal Joints – Differential and Rear Axle – Hotchkiss Drive and Torque Tube Drive – Introduction to rear wheel drive.

STEERING, BRAKES AND SUSPENSION **9 hours**

Wheels and Tyres – Wheel Alignment Parameters - Steering Geometry and Types of steering gear box– Power Steering – Types of Front Axle – Suspension systems – Braking Systems – Types and Construction – Diagonal Braking System – Antilock Braking System.

ALTERNATIVE ENERGY SOURCES **8 hours**

Use of Natural Gas, LPG, Biodiesel, Alcohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel Cells – Introduction to off road vehicles.

Theory :45 hours **Total:45 hours**

REFERENCES:

1. Ed May, “Automotive Mechanics”, Tata McGraw-Hill,2003
2. Kirpal Singh “Automobile Engineering”, Standard Publishers, New Delhi, 2009.
3. William H.Crouse and Donald L.Angline “Automotive Mechanics”, Tata McGraw-Hill, 2007.
4. Srinivasan, “Automotive Mechanics”,Tata McGraw-Hill, 2003.
5. Joseph Heitner, “Automotive Mechanics”,East-West Press, 1999.
6. Halderman, “Automotive Engines:Theory and Servicing”,Pearson, 2009.
7. Ramalingam, K.K, “Automobile Engineering”, Scitech publications, 2008

Approved by BoS Chairman

Programme Electives

Manufacturing& Industrial Engineering

C. Velmurugan
Approved by BoS Chairman

U18MEE0012 **ADDITIVE MANUFACTURING**

L	T	P	J	C
3	0	0	0	3

Course outcomes:

After successful completion of the course, the students should be able to

CO1: Apply the basics of additive manufacturing techniques in manufacturing

CO2: Apply the liquid and solid based rapid prototyping system in suitable applications

CO3: Apply powder based rapid prototyping system in suitable applications

CO4: Apply the different materials for rapid prototyping system

CO5: Apply the concepts of modelling, data processing and reverse engineering in rapid prototyping

CO6: Apply the new technologies in rapid prototyping for various applications

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	M			M				M	S		M	S	S
CO2	S									S			S	S
CO3	S									S			S	S
CO4	S			M			M		S	S	M		S	S
CO5	S	S	S	M					S	S		S	S	S
CO6	S								S	S			S	S

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. Tutorial 6. End semester exam	Course end survey

INTRODUCTION **9 hours**

History – Development of RP systems – Applications in Product Development, Reverse Engineering, Rapid Tooling, Rapid Manufacturing- Principle –Fundamental – File format – Other translators – medical applications of RP – On demand manufacturing – Direct material

LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEM **9 hours**

Classification – Liquid based system - Stereo Lithography Apparatus (SLA), de- tails of SL process, products, Advantages, Limitations, Applications and Uses. Solid based system - Fused Deposition Modelling, principle, process, products, advantages, applications and uses - Laminated Object Manufacturing

Approved by BoS Chairman

POWDER BASED RAPID PROTOTYPING SYSTEMS **9 hours**

Selective Laser Sintering – principles of SLS process, principle of sinter bonding process, Laser sintering materials, products, advantages, limitations, ap- plications and uses. Three-Dimensional Printing – process, major applications, research and development. Direct shell production casting – key strengths, process, applications and uses, case studies, research and development. Laser Sintering System, e-manufacturing using Laser sintering, customized plastic parts, customized metal parts, e-manufacturing - Laser Engineered Net Shaping (LENS).

MATERIALS FOR RAPID PROTOTYPING SYSTEMS **9 hours**

Nature of material – type of material – commercial shapes – selection of material and applications - polymers, metals, ceramics and composites liquid based materials, photo polymer development – solid based materials, powder-based materials – case study.

REVERSE ENGINEERING AND NEW TECHNOLOGIES **9 hours**

Introduction, measuring device- contact type and non-contact type, CAD model creation from point clouds-pre-processing, point clouds to surface model creation, medical data processing - types of medical imaging, software for making medical models, medical materials, other applications - Case study.

Theory: 45 hours **Total:45 hours**

REFERENCES:

1. Dongdong Gu, “Laser Additive Manufacturing of High-Performance Materials”, Springer-Verlag Berlin Heidelberg, 2015.
2. Chee Kai Chua, “Lasers in 3D Printing and Manufacturing, World Scientific, 2016.
3. Rafiq I.Noorani, “Rapid Prototyping: Principles and Applications”, Wiley & Sons, 2006.
4. Chua C.K, Leong K.F and Lim C.S, “Rapid Prototyping: Principles and Applications”, World Scientific, 2003.
5. N.Hopkinson, r.j.m, hauge, p m, dickens, “Rapid Manufacturing: AnIndustrial revolution for the digital age”, Wiley, 2006
6. IAN GIBSON, “Advanced Manufacturing Technology for Medical ap- plications: Reverse Engineering,Software conversion and Rapid Proto- tying”, Wiley, 2006
7. Paul F.Jacobs, Rapid Prototyping and Manufacturing, “Fundamentals of Stereolithography”, McGraw Hill, 2002.
8. D.T.Pham and S.S.Dimov, “Rapid Manufacturing”, Springer Verlog,2001.

U18MEE0013 **MODERN MACHINING PROCESSES**

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Apply the appropriate advanced machining components recognizing the industrial requirements

CO 2: Apply the knowledge of advanced machining process using mechanical energy

CO 3: Apply the principle of material removal by electrical discharge machining

CO 4: Apply the principle of material removal by Chemical and electro chemical energy-based processes

CO 5: Apply the fundamentals of radian energy processes

CO 6: Apply the knowledge and concepts in micro machining process

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S - Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		M												
CO2	S								M			M		M
CO3	S								M			M		M
CO4	S								M			M		M
CO5	S								M			M		M
CO6	M								W			W		W

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION **9 hours**

Need for Modern Advanced Machining Processes - Classification based on Materials – Machining Methods – Energy – Processes Selection – Physical Parameters – Cost of Production – Volume of Production – Shapes of Product – Process Capability – Economical Production

Approved by BoS Chairman

MECHANICAL ENERGY BASED PROCESSES **9hours**

Ultrasonic Machining – Principles – Transducer Type – Concentrators – Abrasive Slurry – Process Parameters – Tool Feed Mechanisms – Advantages – Limitations – Applications – Abrasive Jet Machining – Process – Principle – Process Variables – Material Removal Rate – Advantages and Disadvantages – Applications – Water Jet Machining – Principle Process Variables – Advantages and Disadvantages – Applications.

ELECTRICAL DISCHARGE MACHINING AND ELECTRICAL DISCHARGE WIRE CUT MACHINING **9 hours**

Electrical Discharge Machining – Mechanism of Material Removal – Dielectric Fluid – Electrodes Materials – Spark Erosion Generators – Electrode Feed System – Material Removal Rate – Process Parameters – Tool Electrodes Design – Characteristics of Spark Eroded Surfaces – Advantages and Disadvantages – Applications – Electrical Discharge Wire Cut and Grinding – Principle – Wire Feed System – Advantages and Disadvantages – Applications.

CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES **9 hours**

Chemical Machining – Fundamentals – Principle – Classification – Selection of Etchant – Chemical Milling – Engraving – Blanking – Drilling – Trepanning - Advantages – Disadvantages – Applications – Electro Chemical Machining – Electro Chemistry Process – Electrolytes – Properties – Material Removal Rate – Tool Materials – Tool Feed Systems – Design of Electrolyte Flow – Process Variables – Advantages – Disadvantages – Applications – Electro Chemical Grinding – Honing – Cutting Off – De burring – Turning.

ELECTRON BEAM – LASER BEAM – ION BEAM PLASMA ARC MACHINING AND MICRO MACHINING **9 hours**

Electron Beam Machining – Principle – Generation – Control of Electron Beam – Advantages – Disadvantages – Applications – Laser Beam Machining – Principle – Solid – Gas – Laser Methods – Applications – Thermal Features – LBM – Advantages – Disadvantages – Applications – Ion Beam Machining – Equipment – Process Characteristics – Advantages – Disadvantage – Applications – Plasma Arc Machining – Principle – Gas Mixture – Types of Torches – Process Parameters – Advantages – Disadvantages – Applications – Introduction – Definition – Micro Machining – Classification of Micro Machining – Nano Machining – Nano Finishing - Mechanical – Thermal Micro Machining – Electro Discharge – Electron Beam – Laser Beam –Electro Chemical – Nano Finishing

Theory: 45 hours **Total: 45 hours**

Approved by BoS Chairman

REFERENCES:

1. Vijay.K. Jain "Advanced Machining Processes", Allied Publishers Pvt. Ltd., New Delhi, 2002.
2. Pandey P.C., and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2001.
3. Mc Geough, "Advanced Methods of Machining" Chapman and Hall, London, 2002.
4. Paul De Garmo, Black, J.T.and Ronald. A. Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., New Delhi, 2001.
5. Benedict. G.F., "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 2003.
6. Amitadha Bhattacharyya, "New Technology", The Institution of Engineers, India.
7. "Production Technology" HMT Bengaluru, Tata McGraw Hill Publishing company Limited, New Delhi, 2006

Approved by BoS Chairman

U18MEE0014	WELDING AND ALLIED PROCESSES	L	T	P	J	C
		3	0	0	0	3

CO1: Provide the relationship between process parameters and their influence on GMAW and GTAW weld Quality.

CO2: Find power requirement, weld deposition rate and percent dilution calculations for Submerged Arc Welding and Discuss Process characteristics of Plasma Arc Welding processes.

CO3: Obtain the weldability of Resistance Welding process and Welding current and Electrode feed rate calculation for Electroslag Welding Processes

CO4: Deliberate on Operation, Process Characteristics and Applications of Electron and Laser beam welding processes.

CO5: Distinguish the applications of various allied joining processes and provide the economics analysis of a welding process

CO6: Design a weld joints based on weld stress and suggest suitable weld quality test for a given applications

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M												
CO2	S								M			M		M
CO3	S								M			M		M
CO4	S								M			M		M
CO5	S								M			M		M
CO6	M								W			W		W

ARC WELDING PROCESSES **9 hours**

Heat Sources, Power Sources, Arc Phenomena, Arc Blow, Power Source Characteristics, V-I, Relationship, Different Types of Electrodes and their applications, Electrode Polarity, Shielding Gas, Use of Pulsed Arc and GTA Spot Welding.

PLASMA ARC WELDING PROCESSS **6 hours**

Special Features of Plasma-Arc Transferred and Non- Transferred Arc, Keyhole and Puddle-In Mode of Operation, Process Characteristics and Applications, Advantages and limitations.

Approved by BoS Chairman

RESISTANCE AND SOLID-STATE WELDING **8 hours**

Upset and Flash Butt Welding, Electro Slag and Electro Gas Welding. Solid State Welding: Friction Welding, Friction Stir and Induction Pressure Welding, Process Characteristics and Applications, Explosive, Diffusion and Ultrasonic Welding, Principles of Operation, Process Characteristics and Applications Weldability of Resistance Welding process calculations. Welding current and Electrode feed rate calculation for Electroslag Welding

ELECTRON AND LASER BEAM WELDING **9 hours**

Electron Beam Welding in Different Degrees of Vacuum, LBW: Physics of Lasers, Types of Lasers, Operation, Process Characteristics and Applications, Advantages and Limitations.

OTHER BONDING PROCESSES **6 hours**

Adhesive Bonding, Thermal Cutting Processes, Metal Surfacing and Spraying Processes, Automation in Welding, Specific Welding Applications and Innovations, Economics of Welding, Safety in Welding, Standard Time and Cost Calculation.

TESTING AND DESIGN OF WELD JOINTS **7 hours**

Design Criteria and Quality Control of Welds. Edge preparation Types of Joints, Weld Symbols. Stresses in Butt and Fillet Welds – Weld Size Calculations, Design for Fatigue. Testing of Welds – Tensile, Bend, Hardness, Impact, Notch and Fatigue Tests, Life Assessment of Weldment

References

1. Robert W. Mesler Jr. Principles of Welding: Processes, Physics, Chemistry, and Metallurgy, John Wiley& Sons. Inc, 2007.
2. Parmer R. S., 'Welding Processes and Technology', Khanna Publishers, 2003.
3. Kearns W. H, 'Welding Handbook (Welding Processes)', Volume II and III, 7th Edition, AWS, 1984
4. Parmer R. S., 'Welding Engineering and Technology', Khanna Publishers, 2004.
5. Nadkarni S.V., 'Modern Arc Welding Technology', Oxford and IBH Publishing, 1996.
6. H.S.Bawa " Manufacturing Technology-I" Tata Mc Graw Hill Publishers New Delhi 2007.

Approved by BoS Chairman

U18MEE0015 **LEAN MANUFACTURING**

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Apply the basic concepts of lean manufacturing

CO 2: Apply forecasting systems and supply chain management concept for effective operational decision making

CO 3: Apply capacity planning for managing multistage production system

CO 4: Apply the concepts of pull production systems for better manufacturing performance

CO 5: Apply JIT philosophy to improve product flow

CO 6: Apply theory of constraints for shop scheduling and shop floor control

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M						M							M
CO2	M								M	M				S
CO3	M					M				M				S
CO4	M									M				S
CO5	M				M				M	M				S
CO6	M									M				S

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

Approved by BoS Chairman

LEAN MANUFACTURING - OVERVIEW **9 hours**

Measures of competitiveness, Functional areas of firm, Product design, manufacture, delivery, Principles of Production system –Learning curves- Product demand life cycle-Capacity balancing, Role of inventory and information.

MANUFACTURING STRATEGY AND SUPPLY CHAIN **9 hours**

Forecasting systems – Purposes and uses of forecasts, manufacturing strategy – Dimensions, Aggregate planning – Planning tradeoffs.

Supply chain management concepts –Logistic information systems-Product design and customization-Vendor selection and contracting-Operational decisions in distribution systems.

MULTISTAGE PRODUCTION SYSTEMS **9 hours**

Materials requirement planning, Capacity Planning-Rough cut capacity planning-Capacity requirement planning-Load Reports-Incorporating Stochastic behavior, Lot sizing decisions, Managing change, Limitations of MRP, Introduction to multistage product structures, Types of inventory, Inventory costs.

DECENTRALIZED PULL SYSTEMS& JIT PHILOSOPHY **9 hours**

Kanban systems –Single and dual systems-Scheduling rules, Environmental regulations, Constant work in process pull alternative (CONWIP)-Performance

JIT production systems, Improving the production environment towards JIT– Improving product flow– The transition to lean

SHOP SCHEDULING & SHOP FLOOR CONTROL **9 hours**

Scheduling system requirements, goals and measures of performance – Theory of constraints-Flow shop scheduling

Shop Floor Control system architecture – Manufacturing execution system – Tool management system – Flexible manufacturing systems.

Theory: 45 hours **Total:45 hours**

REFERENCES:

1. Michael L George, David T Rowlands, Bill Kastle, “What is Lean Six Sigma”, McGraw-Hill, New York, 2007.
2. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2003.
3. Micheal Wader, “Lean Tools: A Pocket guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.

Approved by BoS Chairman

4. Kenichi Sekine, “One-piece flow”, Productivity Press, Portland, Oregon, 2005.
5. Joseph A De Feo, William W Bearnard “Juran Institute’s Six Sigma Break Through and Beyond”, Tata McGraw-Hill Edition, New Delhi, 2004.
6. Richard B ChaseF. Robert Jacobs and Nicholas J Aquilano, “Operations Management for Competitive Advantage”, McGraw Hill, 2006.
7. Poka - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 2004.
8. Alan Robinson “Continuous Improvement in Operations”, Productivity Press, Portland, Oregon, 2003.

Approved by BoS Chairman

U18MEE0016 **PLANT LAYOUT AND PROCESS DESIGN**

L	T	P	J	C
3	0	0	0	3

Course outcomes
After successful completion of the course, the students should be able to
CO 1: Outline the importance of plant location analysis.
CO 2: Extend types of layout and infer steps in layout design.
CO 3: Apply production planning techniques in product design and development.
CO 4: Outline process flow tasks and measures for managing flow variability.
CO 5: Analyze the importance of process design.
CO 6: Classify the various techniques of inventory management.

Pre-requisite: NIL

CO/PO Mapping

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	S								S	S				S
CO 2	S								S	S				S
CO 3	S	M	M						M	M				S
CO 4	S		M						M					S
CO 5	S	M							M	M				S

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

PLANT LOCATION **9 Hours**

Plant Location analysis – Importance – Location Decisions – Classifications of location decisions- Location decision factors- Process of selecting a new plant – Comparisons between Service and Manufacturing Locations -Globalization and MNC's - Location and layout.

Approved by BoS Chairman

PLANT LAYOUT **9 Hours**

Need for a layout study- Generic steps involved- Types of layout-Product, Process, Fixed Position, Combined layouts- Factors Influencing layout- Objectives of layout problems- Steps in layout design - Plant layout Procedure – Steps and Approaches.

PRODUCTION PLANNING AND CONTROL **9 Hours**

Introduction and Evolution – Objectives – Benefits – Functions – Types of Production – Product Design and Development-Product Analysis–Profit considerations - Standardization, Simplification, Specialization - Break even analysis.

PROCESS DESIGN **9 Hours**

Process flow and tasks - Process flow diagram and Flow Charts –Process performance measures –Littles law – Flow time measurement-Starvation and blocking- Process flow structures- Managing flow variability- Process Design - Process improvement.

INVENTORY CONTROL **9 Hours**

Inventory Analysis – Objectives and Purpose of holding stock - Costs and risks associated with inventory-Techniques of Inventory Management-ABC, EOQ, EPQ, Order Point Problems, Two bin technique, VED, HML, FSN, JIT.

Theory: 45 Hours **Total:45 Hours**

REFERENCES:

1. Fred E Meyers, “Plant Layout and Material Handling”, Prentice Hall, 1999.
2. James A. Tompkins, John A. White, Yavuz A. Bozer and J. M. A. Tanchoco “Facilities Planning”, John Wiley & Sons, 2003.
3. Khanna, O. P., “Industrial Engineering and Management”, Dhanpatrai and Sons, 2003.
4. Martand Telsang, “Industrial Engineering and Production Management”, S. Chand and Company, Second Edition, 2006.
5. Samson Eilon, “Elements of production planning and control”, Universal Book Corpn.2001
6. Richard Francis, L. Leon McGinnis, F. Jr., John White, A., “Facility Layout and Location – an Analytical Approach”, Prentice Hall of India., 2nd Ed.
7. G. Halevi and R.D. Weill, “Principles of Process Planning” Chappman and Hall, Madras 1995.

Approved by BoS Chairman

U18MEE0017	LOGISTICS AND SUPPLY CHAIN NETWORKS	L	T	P	J	C
		3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Justify significance of a logistics and its relationship to supply chain management.

CO 2: Identify and resolve contemporary issues in a logistic environment

CO 3: Understand basics of supply chain and its overview

CO 4: Analyze impact of sourcing decision in supply chain performance

CO 5: Build distribution network design by analyzing its influencing factors

Pre-requisite: NIL

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M							M	M	M				M
CO2	M								M	M				M
CO3	M							M	M	M				M
CO4	M								M	M				M
CO5	M							M	M	M				M

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

LOGISTICS **15 hours**

Evolution – Significance of Logistics- Progression of competitive advantage – Value chain- Key activities and processes – Logistic strategy – Hierarchy of logistic management decisions – Relationship of Logistics to Marketing and Production -Logistics Integration – Nodes and links in logistic networks –- Logistic Environment – Cost tradeoff in Logistics - Contemporary issues in logistics – Logistics versus supply chain management - Key to fast cycle logistics.

C. Velmurugan

Approved by BoS Chairman

SUPPLY CHAIN BASICS **10 hours**

Introduction - Traditional scope of the supply chain- Evolution of supply chain – Supply chain overview and Objectives – Flow in supply chain- Decision phases of a supply chain- Process view of a supply chain- Cycle view and Push/Pull view - Supply chain Macro process - Case studies of successful supply chains.

SOURCING DECISIONS AND SUPPLY CHAIN PERFORMANCE **10 hours**

Role of sourcing and benefits of effective sourcing decisions- Supplier scoring and assessment factors - Supplier selection - Contracts and supply chain performance- Design collaboration- The Procurement Process - Product Categorization-Sourcing planning and analysis- Framework of the drivers of Supply Chain performance - Achieving a strategic fit.

DISTRIBUTION AND SUPPLY CHAIN NETWORK DESIGN **10 hours**

Introduction to distribution channels - Role of distribution in a supply chain- Factors Influencing distribution network design- Design options for a distribution network- Distribution Networks in Practice - Network design decisions-Factors influencing network design decisions- Framework for global site location-Conventional networks and tailored networks.

Theory: 45 hours **Total: 45 hours**

REFERENCES:

1. Sunil chopra Peter meindl, D.V. Kalra," Supply chain management", Pearson Education, Prentice Hall of India, 2010.
2. Rahul. V. Altekar, "Supply Chain Management, Concept and cases", PHI, 2009.
3. V. Sople "Logistics Management" Pearson India, 2012.

Approved by BoS Chairman

U18MEE0018 **INDUSTRIAL SAFETY**

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Understand the industrial safety, health standards and safety measures

CO 2: Illustrate the philosophies behind industrial accidents and hazards

CO 3: Analyze about Industrial fatigue, Environmental factors and Industrial waste

CO 4: Discuss about human side of safety

CO 5: Illustrate human welfare and discuss about handling emergencies

CO 6: Study the different types safety organization and acts

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			M								M	M		
CO2			M			M					M			
CO3			M				M				M			
CO4			M								M			M
CO5			M								M			M
CO6			M								M			

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION - SAFETY **8 hours**

Definition-Milestones in industrial safety movement-safety responsibility and organization – Occupational safety and health administration (OSHA) –safety measures in planning, production and inspection – safety and productivity

INDUSTRIAL ACCIDENTS AND HAZARDS **8 hours**

Introduction- types of accidents in industry – Causes and prevention of accidents –accident reporting – accident reporting and analysis –Classification of hazards – Hazard management program- Major Industrial hazards – safety audit

Approved by BoS Chairman

INDUSTRIAL FATIGUE, ENVIRONMENTAL FACTORS, AND INDUSTRIAL WASTE

7 hours

Fatigue – types, factors contributing to fatigue, Environment – Temperature, noise, illumination, vibration, heat, ventilation and air-conditioning - Waste – classification – harmful effect – primary and secondary treatment- waste disposal

HUMAN SIDE OF SAFETY **8 hours**

Personal protective equipment – Need, choice, respiratory and non-respiratory protective equipment, Training and maintenance- Occupational health problems – diseases and first aid - Fire hazards and prevention, Electrical hazard prevention and safety

WELFARE AND HANDLING EMERGENCIES **7hours**

Employee welfare-Statutory welfare schemes, Health hazards-Control strategies- Non- statutory schemes - Emergencies – need, objectives and emergency planning process- Safety symbols – signs, colors and categories -

SAFETY ORGANIZATION AND ACTS **7 hours**

Purpose of a safety organization-Safety policy- Safety committee- types- Role of safety coordinator- Responsibilities, Interferences and Sufferings of safety supervisor-Safety publicity- ISO14000 – Environmental management systems – ISO 9000 – Factories act 1948.

Theory : 45 hours **Total: 45 hours**

REFERENCES:

1. Krishnan N.V., “Safety in Industry", Jaico Publisher House, 2005.
2. Singh, U.K. and Dewan, J.M., "Safety, Security and risk management", APH Publishing Company, New Delhi, 2005.
3. C. Ray Asfahl, David W. Rieske, “Industrial Safety and health management”, Prentice Hall,2009.
4. R.K. Mishra,“Safety Management”, AITBS publishers, 2012.
5. Krishnan N.V., “Safety in Industry", Jaico Publisher House, 2005.
6. Singh, U.K. and Dewan, J.M., "Safety, Security and risk management", APH Publishing Company, New Delhi, 2005.
7. C. Ray Asfahl, David W. Rieske “Industrial Safety and health management”, Prentice Hall,2009.
8. R.K. Mishra,“Safety Management”, AITBS publishers, 2012.

Approved by BoS Chairman

U18MEE0019 **INDUSTRIAL MARKETING**

L	T	P	J	C
3	0	0	0	3

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Understand and explain industrial marketing system and concepts.

CO 2: Classify industrial markets and list models of organizational buying behaviour.

CO 3: Analyse importance of marketing information systems and marketing research processes.

CO 4: Define industrial products and recall the factors influencing its pricing decisions.

CO 5: Dissect channel design process and appraise industrial communication programs.

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			M				M				M			S
CO2			M								M			S
CO3			M						W		M			S
CO4			M								M			S
CO5			M				S		W	S	M			S
CO6			M				M				M			S

Course Assessment methods

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION **9 Hours**

Introduction to Industrial Markets - Industrial Marketing System - Concepts - Characteristics – Definition – Exchange processes – Characteristics of Industrial and Consumer markets – Industrial Market demand – Cross elasticity of demand.

INDUSTRIAL PURCHASING **9 Hours**

Types of Industrial Customers - Purchasing practices - Industrial Buyer Behaviour – Industrial buying situation – Decision Making Units – Models of Organizational buying behavior- Modern Purchasing terminologies.

Approved by BoS Chairman

MARKETING PLANNING AND RESEARCH **9 Hours**

Business Marketing – Marketing Planning – Corporate Strategic Planning – Target Marketing - Marketing Information Systems – Market Evaluation - Role of IT in Marketing Information Systems - Definition and Process of Marketing Research - Research Instruments.

PRODUCT DEVELOPMENT AND PRICING **9 Hours**

Industrial Products and Services definition - New Industrial Product Development – Product Life Cycle - Marketing strategies - Industrial Pricing Characteristics- Influencing factors in pricing decisions of Industrial Markets-Classification of costs-Pricing Strategies.

CHANNEL DESIGN **9 Hours**

Channel Design Process - Economic performances and channel management decisions-Industrial Logistics system- Role and Characteristics of Industrial Distributors- Sales Promotion – Personal Selling - Sales Force Management – Advertising in Industrial Marketing – Industrial Communication programs.

REFERENCES

1. Hawaldar, K. Krishna, INDUSTRIAL MARKETING, TATA McGraw-Hill Publishing Company Limited, New Delhi. 2008.
2. Milind T. Phadtare, INDUSTRIAL MARKETING, Prentice Hall of India Pvt. Ltd, New delhi,2008
3. Philip Kotler and Gary Armstrong "Principles of Marketing", Prentice Hall of India, 2008.
4. Michael D Hautt and Thomas W Speh, INDUSTRIAL MARKETING MANAGEMENT, TheDyden Press.
5. Peter M. Chisnall, STRATEGIC INDUSTRIAL MARKETING; Prentice-Hall International
6. Robert R. Reeder, Briety & Betty H. reeder, INDUSTRIAL MARKETING, Prentice Hall of India Pvt. Ltd, New delhi,2008.

L	T	P	J	C
1	0	0	0	1

U18MEC0001 PRODUCT DESIGN AND DEVELOPMENT

Prerequisite: No Prerequisite

CO1: Apply concepts of product development and outline product planning process

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING 5 Hours

Characteristics, duration, the challenges and cost of successful product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, the AMF organization. The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources, complete pre project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS 5 Hours

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING 5 Hours

Concept generation activity, clarify the problem search externally and internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

REFERENCES:

1. Karl Ulrich,T, Steven Eppinger, D, "Product Design and Development", McGraw Hill, 2015.

2. Chitale, AK, Gupta, RC, "Product Design and Manufacturing" PHI, 2013.

3. Timjones, "New Product Development: An Introduction to a multifunctional process", Butterworth-Heinemann, 1997.

4. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, A, "Product Design for Manufacture and Assembly", CRC Press, 2011

Approved by BoS Chairman

U18MEC0002 SMART MANUFACTURING

L	T	P	J	C
1	0	0	0	1

Prerequisite – U18MET2001 Manufacturing Technology

Introduction **5 Hours**

Introduction to smart manufacturing, Manufacturing and Assembly Technology, Automated Production Systems, Handling Systems, Industrial Robots, Design and planning of automated production facilities, Benefits of SM.

Components and Elements of Manufacturing **5 Hours**

Internet of Things, Machine learning, Big data. Elements of Manufacturing: Sensor networks and Devices.

Data Management **5 Hours**

Reporting Methodology, Collection, consolidation, and reporting of the data Management of smart manufacturing processes and Augmented Production, Challenges in implementation.

Textbooks & Reference Books:

1. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X.

2. Lucia Knapcikova, Michal Balog, Dragan Peraković, Marko Periša" New Approaches in Management of Smart Manufacturing Systems: Knowledge and Practice" Springer Nature, 30-Jun-2020 - Technology & Engineering.

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		L	T	P	J	C
U18MEC0003	**NANOTECHNOLOGY: MECHANICAL ENGINEERING'S NEW FRONTIER**	**1**	**0**	**0**	**0**	**1**

BASICS OF NANO TECHNOLOGY **06 Hours**

Introduction – nanomaterial – nanoscience- nano engineering -nanomanufacturing – PVD and CVD method – Characterization Techniques – SEM – FESEM – AFM – TEM – EDS and X-RD analysis.

NANOCOMPOSITES **06 Hours**

Composites – types – nano composites – fabrication methods – Solid and Liquid state – properties analysis.

APPLICATION ON NANOTECHNOLOGY **03 Hours**

Nanotechnology – robotics- combustion-biomedicine- heat transfer.

(Nanoengineering is also one of the most interdisciplinary of the sciences, requiring knowledge of mechanical engineering, chemical engineering, electrical engineering, biology, physics, photonics, and materials science – by Mark Crawford, ASME)

COURSE OUTCOME

1. Have a better fundamental understanding of nanotechnology.

2. Apply the concept of microscope techniques to find the structural changes nanomaterials.

3. Apply the nanotechnology to solve the mechanical engineering problems.

REFERENCES

1. Handbook of nanophase and nanostructured materials. Ed. by Zhong Lin Wang, Yi Liu, Ze Zhang. V.1. Synthesis; V.2. Characterization; V.3. Materials systems and applications I; V.4. Materials systems and applications II. Kluwer Academic/ Plenum Publishers, 2003.

2. P. J. Harris. Carbon nanotubes and related structures. Cambridge University Press, 1999.

3. Philips.V.A, "Modern Metallographic Techniques and their Applications", Wiley Interscience, 1971.

U18MEC0504 ANSYS Multiphysics

L	T	P	J	C
0	0	2	0	1

Course outcomes

After successful completion of the course, the students should be able to

CO 1: Analyse stress and vibration in various components in the design perspective.

Pre-requisite: Strength of Materials

Course Assessment methods:

Direct	Indirect
End Semester Exam	Course End Survey

Course Content

1. Stress analysis of a plate with a circular hole.
2. Stress analysis of rectangular L bracket
3. Stress analysis of an axi-symmetric component
4. Stress analysis of a roof truss.
5. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
6. Mode frequency analysis of a 2 D component
7. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
8. Harmonic analysis of a 2D component
9. Thermal stress analysis of a 2D component
10. Conductive heat transfer analysis of a 2D component
11. Convective heat transfer analysis of a 2D component
12.Introduction to ANSYS Workbench

Total: 30 Hours

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U18MEC005 RENEWABLE ENERGY SOURCES

L	T	P	J	C
1	0	0	0	1

ENERGY AND ENVIRONMENT **7 Hours**

Primary energy sources - world energy resources - energy cycle of the earth and Global warming – Renewable energy resources and their importance - Potential impacts of harnessing the different renewable energy resources.

DIRECT ENERGY CONVERSION SYSTEM **8 Hours**

Fuel cells and its classification; Transport mechanism in fuel cells and concept of energy conversion. Solid oxide fuel cells (SOFC); PEM fuel cells; Direct methanol fuel cells (DMFC), Molten carbonate fuel cell (MCFC)-. Hydrogen conversion and storage systems.

REFERENCES:

1. Rai G.D, “Non-conventional Energy sources” 4th edition (24th Reprint), Khanna Publishers, New Delhi, 2009.
2. Kothari “Renewable Energy Sources and Emerging Technologies”, Eastern Economy Edition, 2009.
3. Sukhatme, S.P., “Solar Energy, Principles of Thermal Collection and Storage”, TataMCGraw Hill, 2008.
4. S.Rao and Parul ehar, “Energy Technology: Non conventional, Renewable and Conventional”, Khanna Publishers, 2009.
5. G.D. Rai, “Non Conventional Energy Sources”,Khanna Publishers, New Delhi, 1999.
6. Twidell, J.W. and Weir, A., “Renewable Energy Sources”,E&FN Spon Ltd., 1986
7. B.H.Khan, “Non conventional energy resources”; Tata Mcgraw hill, 2006.
8. John Andrews and nick jelly, “Energy science principles, technologies and impacts”, oxford university press, 2007.
9. Bent Sorensen, “Renewable energy physics, engineering, environmental impacts, economic & planning”, academic press, 2011.

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U18MEC0206 Advanced Heat Transfer Enhancement Techniques

L	T	P	J	C
1	0	0	0	1

Classification of advanced heat transfer enhancement techniques- Active and Passive methods **- 2 Hours**

Active heat transfer enhancement techniques-Promotion of forced convection **- 1 hours**

Passive heat transfer enhancement techniques-Surface extrusion, Boundary layer disruption, Effective thermal conductivity enhancement **- 2 hours**

Blocking and meshing in ICEM CFD [Lab Component] **- 5 hours**

Analysis using Fluent- Flow through heat exchanger and Application of Nanofluid [Lab component]

5 hours

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U18MEE0020 REVERSE ENGINEERING

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Apply the fundamental concepts and principles of reverse engineering in product design and development.

CO 2 Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.

CO 3 Apply the concept and principles of material identification and process verification in reverse engineering of product design and development

CO 4 Apply the concept and principles of data processing, part performance in reverse engineering of product design and development.

CO 5 Apply the concept and principles of system compatibility in reverse engineering of product design and development.

CO 6 Analyse the various legal aspect and applications of reverse engineering in product design and development.

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	W	W								W	M	W
CO2	S	S	W	M								W	M	W
CO3	S	S	W	M								W	M	W
CO4	S	S	W	M		W	W	W				W	M	W
CO5	S	S	W	M		W	W	W				W	M	W
CO6	W	M	W	W		W	W	W				W	S	M

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Open book test, Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-End Survey

INTRODUCTION TO REVERSE ENGINEERING & GEOMETRIC FORM 9 Hours

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION

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9 Hours

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure.

MATERIAL IDENTIFICATION AND PROCESS VERIFICATION 9 Hours

Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY 9 Hours

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.

LEGAL ACCEPTANCE AND INDUSTRIAL APPLICATIONS OF REVERSE ENGINEERING 9 Hours

Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

Theory: 45 Tutorial: 0 Practical:0 Project: 0 Total: 45 hours

References:

1. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011.
2. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer-Verlag London Limited 2008.
3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
4. Linda Wills, "Reverse Engineering", Kluver Academic Publishers, 1996
5. Donald R. Honsa, "Co-ordinate Measurement and Reverse Engineering", American Gear Manufacturers Association

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U18MEE0021	DESIGN FOR SUSTAINABILITY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Select relevant process; apply the general design principles for manufacturability; GD&T

CO 2 Apply design considerations while designing the cast components

CO 3 Apply design considerations while designing the welded components

CO 4 Apply design considerations while designing the formed and machined Components

CO 5 Apply design considerations for assembling systems

CO 6 Apply design considerations for environmental issues

Pre-requisite: Manufacturing Technology

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S	S		S		S	M	W				S	M
CO2	M	S	S		S		S	M	W				S	M
CO3	M	S	S		S		S	M	W				S	M
CO4	M	S	S		S		S	M	W				S	M
CO5	M	S	S		S		S	M	W				S	M
CO6	M	S	S		S		S	M	W				S	M

Course Assessment methods:

Direct
4. Continuous Assessment Test I, II 5. Open book test, Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 6. End Semester Examination
Indirect
1. Course-End Survey

INTRODUCTION **9 Hours**

Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning & Tolerance (GD&T) – Form tolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry – run out tolerancing: circular and total – Supplementary symbols

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CAST & WELDED COMPONENTS DESIGN **9 Hours**

Design considerations for: Sand cast – Die cast – Permanent mold parts. Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash &Upset weldment

FORMED & MACHINED COMPONENTS DESIGN **9 Hours**

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts – Forged parts. Design considerations for: Turned parts – Drilled parts – Milled, planned, shaped and slotted parts– Ground parts

DESIGN FOR ASSEMBLY **9 Hours**

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly – Computer Application for DFMA

DESIGN FOR ENVIRONMENT **9 Hours**

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 manufacture – Design for energy efficiency – Design to regulations and standards

Theory: 45 **Tutorial: 0** **Practical:0** **Project: 0** **Total: 45 hours**

References:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker
2. Bralla, Design for Manufacture handbook, McGraw hill, 1999
3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995
5. Fixel, J. Design for the Environment McGraw Hill., 1996
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996
7. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009
8. Harry Peck, Designing for manufacture, Pitman– 1973

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U18MEE0022 ADVANCED STRENGTH OF MATERIALS

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO1: Apply fundamental concepts of 3 D stress system and compute stresses and deformations in structural members.
CO2: Compute stresses in curved members
CO3: Identify the buckling and compute stresses due to various loading conditions in flat plates
CO4: Apply elastic membrane ideology and compute stresses due to torsion in non-circular sections
CO5: Identify the stresses in rotating discs and compute the stresses
CO6: Apply the concepts of contact stresses in two bodies having either a point or a line contact.

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M											M	
CO2	M	M											M	
CO3	M	M											M	
CO4	M	M											M	
CO5	M	M											M	
CO6	M	M											M	

Stress-Strain **8 hours**

State of stress at a point – Stress and Strain Tensors - Equilibrium equations – Generalised Hooke's Law – St.Vennant's Principle - Plane Strain, plane Stress - Airy's Stress Function

Curved Beams **9 hours**

Unsymmetrical bending of beams - Radial and circumferential stresses – Winkler-Bach formula – Deflection of thick curved bars – Ends restrained – Closed ring subjected to concentrated and uniform loads

Flat plates **7 hours**

Stresses due to bending – Stresses in circular, square and rectangular plates due to various end conditions and loads – Buckling in plates

Torsion of non-circular sections **7 hours**

Torsion in rectangular section bars – Elastic membrane analogy – Torsion in hollow thin-walled tubes.

Rotating Discs **7 hours**

Stresses due to rotation – Radial and tangential stresses – solid disc and disc with a central hole – uniform strength discs – plastic collapse

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Contact stresses **7 hours**

Geometry of contact surfaces – Stresses in bodies with point and line contact – Deflection of bodies in point contact

REFERENCES:

10. Boresi A P and Schmidt R J , "Advanced Strength of Materials", John Wiley and Sons, New Delhi, 2012.
11. Srinath L S, “Advanced Mechanics of Solids”, Tata McGraw Hill, New Delhi, 2017.
12. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi, 2015.
13. Timoshenko and Goodler, “Theory of Elasticity”, McGraw-Hill, 2006.
14. Hartog D, "Advanced Strength of Materials", McGraw Hill Inc, New Delhi, 1987.

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U18MEE0023 **DESIGN THINKING**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 To introduce the idea of design thinking in product development

CO 2 To motivate and implement their creativity

CO 3 To understand the practice of design thinking

CO 4 To Improve their creativity and innovation

CO 5 To learn the application of design thinking for the IT industry

CO 6 To design using the methodology

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S											S	
CO2	S	S				M							S	
CO3	S					M								M
CO4	S			M									S	
CO5														M
CO6													S	

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-End Survey

INTRODUCTION **9 hours**

Understanding Design thinking – Need for design creativity – creative thinking for quality – essential theory about directed Creativity – Shared model in team-based design – Theory and practice in Design thinking – Exploring work of Designers across world – Prototyping.

CREATIVITY **9 hours**

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions, Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation, and Incubation – Creativity and Motivation the Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management.

Approved by BoS Chairman

DESIGN **9 hours**

Process Design, Emotional Design – Three levels of Design – Visceral, Behavioural and Reflective-Recycling and availability – Tools for Design Thinking – Real-Time design interaction capture and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design.

INNOVATION **9 hours**

Achieving Creativity –Introduction to TRIZ methodology of Inventive Problem Solving – Design Thinking in IT – Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping – DT For strategic innovations – Growth – Story telling - Predictability – Strategic Foresight - Change –Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture.

REFINEMENT **9 hours**

Design Thinking Workshop Empathize-Thinking in Images - Thinking in Signs - Appropriation – Humour – Personification - Visual metaphors – Modification -. Thinking in Shapes - Thinking in Proportions - Thinking in Colour.

Theory: 45 **Tutorial: 0** **Practical:0** **Project: 0** **Total: 45 hours**

REFERENCES:

1. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.

2. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011

3. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

4. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2003

5. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999

U18MEC0007 **INDUSTRIAL ROBOTICS**

L	T	P	J	C
1	0	0	0	1

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO1: Write basic code in both the C++ and C programming languages.

CO2: Learn functioning of a proximity sensor and a servo motor.

CO3: Design and build a variety of servo motor-based robots

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S											S	S
CO2	S	S				M			S				S	S
CO3	S					M						M	S	S

Course Assessment methods:

Direct
1. Continuous Assessment Test 2. Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-End Survey

BASICS OF ROBOTICS **1.5 Hours**

Classifications of Robots - Robot Anatomy Technical Specifications - Grippers and Tools - Applications of Industrial Robots.

ROBOT PROGRAMMING **2 Hours**

Robot Programming - Introduction to Humanoid Robots - Sensors – Types & Principles - Sensors – Scaling, Selection of Sensors

MICRO CONTROLLERS AND DRIVES **3.5 Hours**

Introduction to UNO Microcontroller, PWM and Controller Communications, I/O Devices, Assessment 4 (10 MCQ), Servo Motor – Working, Configuring & Controlling

SOFTWARE CONFIGURATION **4 Hours**

IDE Software Configuration, Serial Functions, Conditional Statements & Loops, While Loops, Special IDE Functions .

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PROJECT WORK **4 Hours**

Robotic Arm Project Material Requirement

Theory: 11 **Tutorial: 0** **Practical:0** **Project: 4** **Total: 15 hours**

References:

1. Thomas.R.Kurfees, “Composite Materials Design and Applications”, CRC Press,London,2002.
2. Tom Taulli “The Robotic Process Automation Handbook”, APress, California, 2020.
3. Layna Fischer, “Intelligent Automation”, Future Strategies Inc, USA, 2019.

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U18MEE0026	SOLAR ENERGY ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO1: Explain the working principle of various instruments used for measuring solar radiation.

CO2: Describe the working principle and performance of solar flat plate collectors.

CO3: Discuss the factors to be considered to design a solar concentrator for various applications.

CO4: Discuss the working principle of various solar devices.

CO5: Explain the photo voltaic cells with their construction details.

CO6: Describe the various solar thermal energy storage systems.

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M								M	M			M	
CO2	M								M	M			M	
CO3	M								M	M			M	
CO4	M						W		M	M			M	
CO5	M								M	M			M	
CO6	M						W		M	M			M	

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-End Survey

INTRODUCTION **9 Hours**

Source of radiation – solar constant– solar charts – Measurement of diffuse, global and direct

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solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder

COLLECTOR AND ITS PERFORMANCE **9 Hours**

Solar Non-Concentrating Collectors- Design considerations – Classification- air, liquid heating collectors –Derivation of efficiency and testing of flat plate collectors –Analysis of concentric tube collector - Solar green house.

CONCENTRATOR **9 Hours**

Design – Classification– Concentrator mounting –Focusing solar concentrators- Heliostats. Solar powered absorption A/C system, water pump, chimney, drier, dehumidifier, still, cooker.

PHOTO-VOLTAIC CELL **9 Hours**

Photo-voltaic cell – characteristics- cell arrays-power electric circuits for output of solar panels-choppers-inverters-batteries-charge regulators, Construction concepts.

APPLICATIONS **9 Hours**

Energy Storage - Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber's salt-organic compounds. Solar ponds.

Theory: 45 **Tutorial: 0** **Practical:0** **Project: 0** **Total: 45 hours**

References:

1. Yogi Goswami, . D. Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003
2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 2001.
3. Duffie J. A and Beckman, W .A., "Solar Engineering of Thermal Process", John Wiley,2003.
4. Tiwari G. N. and Ghosal, M. K. "Fundamentals of Renewable energy Sources", Narosa Publishing House, New Delhi, 2007.
5. W. Shepherd and D. W. Shepherd, "Energy Studies" Imperial College Press, London, 2004.

U18MEE0027	RENEWABLE ENERGY SOURCES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1	Explain the different primary energy sources and renewable energy sources
CO 2	Describe the solar energy measurement procedures and construction of the instruments.
CO 3	Discuss the various elements in solar energy system for various applications.
CO 4	Explain the working principle of wind, tidal and geothermal energy systems.
CO 5	Discuss the technique of harvesting energy from waste and factors considered in designing a biogas plant.
CO 6	Explain the various direct energy conversion systems.

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M								M	M			M	
CO2	M								M	M			M	
CO3	M								M	M			M	
CO4	M						W		M	M			M	
CO5	M								M	M			M	
CO6	M						W		M	M			M	

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-End Survey

ENERGY AND ENVIRONMENT **9 Hours**

Primary energy sources - world energy resources - energy cycle of the earth –environmental aspects of energy utilization, Emissions and Global warming – Renewable energy resources and their importance - Potential impacts of harnessing the different renewable energy resources.

SOLAR ENERGY **9 Hours**

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Principles of solar energy collection - solar radiation - measurements - instruments - data and estimation- types of collectors - characteristics and design principles of different type of collectors, performance and testing of collectors - Solar water and air heaters - performance and applications - solar cooling - solar drying - solar ponds - solar tower concept - solar furnace.

WIND, TIDAL AND GEOTHERMAL ENERGY **9 Hours**

General theory of windmills - types of windmills - design aspects of horizontal axis windmills – applications - Energy from tides and waves – working principles of tidal plants and ocean thermal energy conversion plants - Geothermal power plants. Principle of ocean thermal energy conversion (OTEC).

BIO ENERGY **9 Hours**

Energy from biomass and bio gas plant – types and design of biogas plants – applications - Energy from wastes - utilization of industrial, municipal and agricultural wastes. Emission norms: emission from renewable fuels and its effect on environment, study of environment protection norms ISO 14000, 16000 etc.

DIRECT ENERGY CONVERSION SYSTEM **9 Hours**

Magneto hydrodynamic systems (MHD) - thermoelectric generators – thermionic generators - Fuel cells and its classification; Transport mechanism in fuel cells and concept of energy conversion. Solid oxide fuel cells (SOFC); PEM fuel cells; Direct methanol fuel cells (DMFC), Molten carbonate fuel cell (MCFC)- solar cells - types, EMF generated, power output, losses and efficiency applications. Hydrogen conversion and storage systems.

Theory: 45 **Tutorial: 0** **Practical:0** **Project: 0** **Total: 45 hours**

References:

1. Sukhatme, S.P., “Solar Energy, Principles of Thermal Collection and Storage”, 3rd Edition, TataMCGraw Hill, 2008.
2. S.RAo and Parul ehar, “Energy Technology – Non conventional, Renewable and Conventional, 3rd Edition (6th Reprint), Khanna Publishers, 2009.
3. Garg. H. P and Prakash. J., “Solar Energy - Fundamentals and applications”, T1st revised edition, Tata Mc Graw Hill, 2000.
4. Non-Conventional Energy Sources - G.D. Rai – Khanna Publishers, New Delhi,1999.
5. Renewable Energy Sources - Twidell, J.W. and Weir, A. - EFN Spon Ltd., 1986
6. Rai G.D, “Non-conventional Energy sources” 4th edition (24th Reprint), Khanna Publishers, New Delhi, 2009.
7. “Renewable Energy Sources and Emerging Technologies”, Kothari, Eastern Economy Edition, 2009

Approved by BoS Chairman

U18MEE0028	INTRODUCTION TO OIL AND GAS ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Explain the oil and Gas Facilities

CO 2 Discuss the well head working principle

CO 3 Describe the well head components

CO 4 Illustrate the Gas Separation Process

CO 5 Explain the Gas processing and Recovery

CO 6 Explain the Refining of Petrochemicals

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S											S	
CO2	S	S				M							S	
CO3	S					M							S	M
CO4	S			M									S	
CO5	S												S	M
CO6	S			M									S	M

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-End Survey

INTRODUCTION TO OIL & GAS, FACILITIES & PROCESSES **9 Hours**

Introduction to Oil, Facilities, Exploration, Production Offshore, Onshore, Upstream process sections, Midstream process, refining & petrochemical.

RESERVOIR & WELLHEADS **9 Hours**

Crude oil & Natural gas, Reservoir, Exploration and drilling, Well, Well casing, Completion, Wellhead, Subsea wells, Injections, Artificial lift, Rod pumps, ESP, Gas lift, plunger lift, well workover.

THE UPSTREAM OIL & GAS PROCESSES **9 Hours**

Approved by BoS Chairman

Manifolds & gathering, pipelines and risers, production, test and injection manifolds, Separation, test separators, types of separators, Gas treatment & compression, Oil and Gas storage metering & export

MIDSTREAM PROCESSES **9 Hours**

Gathering, Gas plants, Gas composition, Gas processing, Acid gas removal, dehydration, mercury removal, nitrogen rejection, NGL recovery, Pipelines, Pipeline terminal, Gas pipelines, LNG.

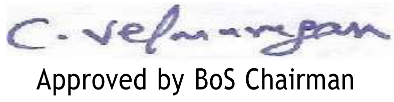
REFINING, PETROCHEMICAL & UTILITY SYSTEMS **9 Hours**

Fractional distillation, Basic products, upgrading and advanced processes, Blending & distribution, Petrochemicals, Utility systems, Process control systems,

Theory: 45 **Tutorial: 0** **Practical:0** **Project: 0** **Total: 45 hours**

References:

1. Young Bai and Qiang Bai, " Subsea Structural Engineering Hand Book", GPP Publishers , USA, Elsevier ,2010
2. John Fowler, " Design Hand Book for API 6A/16A/17D Equipment " Mechanical Engineering Consulting Services and Software , 1998



Approved by BoS Chairman

U18MEE0029	THEORY AND PRACTICE OF NON-DESTRUCTIVE TESTING	L	T	P	J	C
		2	0	2	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Apply basic knowledge of surface NDE techniques which enables to carry out various inspections as per the established procedures.

CO 2 Differentiate various defect types and select the appropriate NDT methods for better evaluation

CO 3 Apply basic knowledge of ultrasonic testing which enables them to perform inspection of various mechanical elements.

CO 4 Explain complete theoretical and practical understanding of the radiographic testing, interpretation and evaluation.

CO 5 Select the appropriate technique and exposure time for a better radiography imaging.

CO 6 Explain the basic physics, mechanisms and applications of the characterization methods commonly used in materials engineering.

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M										M		S
CO2	S													S
CO3	S							S						S
CO4	S					W								S
CO5	S		M			W		S						S
CO6	S	M										M		S

Course Assessment methods:

Direct
1. Continuous Assessment Test I,II 2. Cooperative learning report, Assignment, Group Presentation, Mini Project report. 3. End Semester Examination
Indirect
1. Course-End Survey

SURFACE NON-DESTRUCTIVE ENGINEERING METHODS **10 Hours**

Fundamentals of Visual Testing – vision, lighting, material attributes, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes. Liquid Penetrant Testing (LPT) Principles, types and properties of liquid penetrants, developers –Preparation of test surface – LPT Testing Procedures. Theory of magnetism – ferromagnetic, paramagnetic materials – characteristics of magnetic fields, magnetic hysteresis, magnetization by means of direct and alternating current surface strength.

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ULTRASONIC TESTING AND RADIOGRAPHY **15 Hours**

Principle of pulse echo method, through transmission method, resonance method – Advantages, limitations – contact testing, immersion testing, couplants, Data presentation A, B and C scan displays, comparison of contact and immersion method. Pulse Echo instrumentation, controls and circuits, pulse generation, signal detection, display and recording methods, gates, alarms and attenuators, detectability of defects.

Radiography-Geometric exposure principles, shadow formation, shadow sharpness, X-ray source generation and properties – industrial X-ray tubes. X-ray film – structure and types for industrial radiography film handling and storage. Principles and applications of Fluoroscopy/Real-time, Principle and application of in-motion and flash radiography. Interpretation of radiographs:- Interpretation for welds, castings etc, applications, Inspection standards - applicable codes, standards and specifications.

MATERIAL CHARACTERIZATION TECHNIQUES **10 Hours**

Characteristic X–ray spectrum–Diffraction methods-Laue method, rotating crystal method, powder method – X ray diffractometer–determination of crystal structure–lattice parameter- measurement of residual stress. X-ray fluorescence spectroscopy – EDXRF, WDXRF. Auger Electron spectroscopy, X-ray photoelectron spectroscopy – Optical emission spectroscopy.

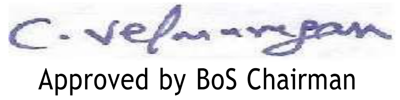
NON-DESTRUCTIVE TESTING PRACTICE **10 Hours**

1. Inspection of weldments using solvent removable visible dye penetrant.
2. Inspection of castings using solvent removable visible dye penetrant.
3. Inspection on ferrous materials by Yoke type MPT method.
4. Inspection of welds by Prod type MPT method.
5. Film interpretation of radiographic films
6. Characterization of alloy using X ray fluorescence spectroscopy
7. Study on calibration of Ultrasonic flaw detector.

Theory: 35 **Tutorial: 0** **Practical: 10** **Project: 0** **Total: 45 hours**

References:

1. C. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1st edition (2001).
2. J. Thomas Schmidt, K. Skeie and P. Maclntire, ASNT Non Destructive Testing Handbook: Magnetic Particle Testing, American Society for Nondestructive Testing, American Society for Metals, 2nd edition (1989).
3. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).
4. B. Raj, C.V. Subramanian and T. Jayakumar, Non Destructive Testing of Welds, Woodhead Publishing, 1st edition (2000).
5. P. J. Shull, Nondestructive Evaluation: Theory, Techniques, and Applications, CRC Press, 1st edition (2002).
6. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition (2002).



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U18MEE0031 PROBLEM SOLVING USING PYTHON	**L T P J C** **2 0 2 0 3**

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Develop algorithmic solutions to simple computational problems Read, write, execute by hand simple Python programs

CO 2 Structure simple Python programs for solving problems.

CO 3 Decompose a Python program into functions

CO 4 Represent compound data using Python lists, tuples, dictionaries

CO 5 Read and write data from/to files in Python Programs

Pre-requisite: NIL

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	W	W		W	W			M	M	S		W		
CO2	W	W		W	W			M	M	S		W		
CO3	W	W		W	W			M	M	S		W		
CO4	W	W		W	W			M	M	S		W		
CO5	W	W		W	W			M	M	S		W		

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Assignments 3. Experimental results analysis/viva 4. Model Examination (lab) 5. End Semester Examination (Theory and lab components)
Indirect
1. Course-End Survey

ALGORITHMIC PROBLEM SOLVING **6 Hours**

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.

DATA, EXPRESSIONS, STATEMENTS **6 Hours**

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.

CONTROL FLOW, FUNCTIONS **6 Hours**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions:

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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

LISTS, TUPLES, DICTIONARIES **6 Hours**

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

FILES, MODULES, PACKAGES **6 Hours**

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

Theory: 30 **Tutorial: 0** **Practical:15** **Total: 45 hours**

List of Experiments

1. Program to calculate the Thermal efficiency of an Otto cycle.
2. Program to calculate the COP of the heat engine.
3. Program to calculate the diameter of the shaft.
4. Program to find the dimensions of a Flexible Flange Coupling
5. Program to plot the equation of the motion of a simple pendulum.

References:

1. 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/).
2. Guido van Rossum and Fred L. Drake Jr, —An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3. John V Guttag, —Introduction to Computation and Programming Using Python,,,,, Revised and expanded Edition, MIT Press , 2013.
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016

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U18MEE0024	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

Course outcomes:

CO1: Apply concepts of product development and outline product planning process
CO2: Apply relative importance of customer needs in establishing product specifications
CO3: Identify concept generation activities and summarize the methodology involved in concept selection and testing
CO4: Outline supply chain considerations in product architecture and understand the industrial design process
CO5: Apply design for manufacturing concepts in estimating manufacturing costs
CO6: Apply principles of prototyping in product development economics and highlight importance of managing projects

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M		M					W			M	
CO2			M										M	
CO3	M		M										S	
CO4			S			W				M	M		M	
CO5			S		M	M								S
CO6					M				M		S			S

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING **9 Hours**

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS **9 Hours**

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

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CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING
9 Hours

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING **9 Hours**

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING PRODUCT DEVELOPMENT ECONOMICS MANAGING PROJECTS **9 Hours**

Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

4. Karl Ulrich,T, Steven Eppinger, D, "Product Design and Development", McGraw Hill, 2015.
5. Chitale, AK, Gupta, RC, "Product Design and Manufacturing" PHI, 2013.
6. Timjones, "New Product Development: An Introduction to a multifunctional process", Butterworth-Heinemann, 1997.
7. Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, "Product Design for Manufacture and Assembly", CRC Press, 2011.

C. Velmurugan

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U18MEE0025 PRODUCT LIFECYCLE MANAGEMENT

L	T	P	J	C
2	0	2	0	3

Course outcomes:

CO1: Apply concepts of product lifecycle management and visioning

CO2: Apply relative importance of product concepts, processes and workflow

CO3: Apply principles of collaborative product development

CO4: Outline considerations in system architecture understand the industrial process

CO5: Apply product lifecycle management strategy and assessment

CO6: Apply the infrastructure assessment, assessment of current systems and applications.

Pre-requisite: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M		M					W			M	
CO2			M										M	
CO3	M		M										M	
CO4			S			W				M	M		M	
CO5			S		M	M								S
CO6						M							M	

Course Assessment methods:

Direct	**Indirect**
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT 6 Hours

Definition, PLM Lifecycle Model, Threads of Product Lifecycle Management, Need for Product Lifecycle Management, Opportunities and Benefits of Product Lifecycle Management, Views, Components and Phases of Product Lifecycle Management, Product Lifecycle Management feasibility study, Product Lifecycle Management Visioning.

PLM CONCEPTS, PROCESSES AND WORKFLOW 6 Hours

Characteristics of Product Lifecycle Management, Environment Driving Product Lifecycle Management, Product Lifecycle Management Elements, Drivers of Product Lifecycle Management, Conceptualization, Design, Development, Validation, Production, Support of Product Lifecycle Management.

COLLABORATIVE PRODUCT DEVELOPMENT 6 Hours

Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Bill of Materials and Process Consistency, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.

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SYSTEM ARCHITECTURE **6 Hours**

Introduction, Types of Product Data, Product Lifecycle Management systems, Features of Product Lifecycle Management System, System architecture, Product information models, Functionality of the Product Lifecycle Management Systems

DEVELOPING A PLM STRATEGY AND ASSESSMENT

6 Hours

Strategy, Impact of strategy, implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.

PRACTICAL: **30 Hours**

1. Streamline collaboration to capture and manage the creation, revision, release of CAD data simulation models and documentations
2. Create, assign and mange task, setting priorities of task to the teams on track,
3. Resolving issues (issue management)
4. View and markup complex 3D product design
5. Change management capabilities
6. Customization and implementation of various industrial practices
7. Conceptualization for Product Lifecycle Management
8. Validation for Product Lifecycle Management
9. Building Product information models

Theory: 30	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

REFERENCES:

8. Michael Grieves, Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Mc Graw Hill, 2015.
9. Martin Eigner, System Lifecycle Management – Engineering Digitalization (Engineering 4.0), Springer Vieweg 2021.
10. Karl Ulrich,T, Steven Eppinger, D, "Product Design and Development", McGrawHill, 2015.
11. Chitale, AK, Gupta, RC, "Product Design and Manufacturing" PHI, 2013.
12. Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, "Product Design for Manufacture and Assembly", CRC Press, 2011.

C. Velmurugan

Approved by BoS Chairman

U18MEE0032 **DATA SCIENCE**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Understand the importance of data science and Python in Engineering.

CO 2 Develop algorithmic solutions to simple computational problems

CO 3 Apply basic statistic tools and techniques

CO 4 Perform data analytics process using python

CO 5 Analyze relevant data using basic statistic tools and techniques

Pre-requisite: U18MEE0031 Problem solving using PYTHON

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, Weak														
COs	**Programme Outcomes (POs)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	W	W	W	W	W			M	W	M		W		
CO2	W	W	W	W	W			M	W	M		W		
CO3	W	W	W	W	W			M	W	M		W		
CO4	W	W	W	W	W			M	W	M		W		
CO5	W	W	W	W	W			M	W	M		W		

Course Assessment methods:

Direct
1. Continuous Assessment Test I, II 2. Assignments 3. End Semester Examination
Indirect
1. Course-End Survey

INTRODUCTION TO DATA SCIENCE AND PYTHON **9 Hours**

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

BASICS OF PYTHON PROGRAMMING **9 Hours**

python, 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

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ROLE OF STATISTICS AND PROBABILITY IN DATA SCIENCE **9 Hours**

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 Regression, Multiple Regression, Logistic Regression

DATA ANALYTICS USING PYTHON **9 Hours**

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

DATA ANALYSIS PROCESS **9 Hours**

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

Theory: 45 **Tutorial: 0** **Practical:0** **Total: 45 hours**

References:

1. Jake VanderPlas "Python Data Science Handbook: Essential Tools for Working with Data" O'Reilly Media, Inc, 2017.
2. Daniel Y. Chen, (2018) "Pandas for Everyone: Python Data Analysis" First edition, Pearson Education, 2018.
3. McKinney, W. "Python for data analysis: Data wrangling with Pandas, NumPy, and IPython" O'Reilly Media,2012.
4. Douglas C. Montgomery, George C. Runger "Applied Statistics & Probability for Engineering" John Wiley & Sons, 2002.
5. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 2012.
6. Swaroop, C. H. "A Byte of Python" Python Tutorial, 2003.
7. Anirban Das Gupta "Probability for Statistics and Machine Learning" Springer link, 2011.
8. Anderson Sweeney Williams "Statistics for Business and Economics, Cengage Learning, 2011.

Web References:

- https://jakevdp.github.io/PythonDataScienceHandbook/index.html
- https://towardsdatascience.com/
- https://www.practicaldatascience.org/html/pandas_dataframes.html
- https://hadrienj.github.i

Approved by BoS Chairman

U18MEE0030 GREEN MANUFACTURING: CONCEPTUAL DESIGN AND ITS PRACTICES

L	T	P	J	C
3	0	0	0	3

Course Outcomes (COs):

After successful completion of this course, the students should be able to:

CO 1 Know the environmental design and selection of eco-friendly materials.

CO 2 Analyse manufacturing processes towards minimization or prevention of air pollution.

CO 3 Know about the Characteristics of Noise Pollution

CO 4 Analyse manufacturing processes towards minimization or prevention of noise pollution.

CO 5 Analyse manufacturing processes towards minimization or prevention of water pollution

CO 6 Evaluate green co-rating and its benefits

Pre-requisite: NIL

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M	M				S				S			
CO2		M	M				S							M
CO3		M	M				S							M
CO4		M	M				S							M
CO5		M	M				S							
CO6		M										M		M

Direct
1. Continuous Assessment Test I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination
Indirect
1. Course-End Survey

Course Assessment methods:

DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT 9 hours

Environmental effects of design -selection of natural friendly material - Eco design - Environmental damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.

AIR POLLUTION SAMPLING AND MEASUREMENT 9 hours

Primary and Secondary Pollutants, Automobile

Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dixide, carbon monoxide, oxidants and ozone

NOISE POLLUTION AND CONTROL **9 hours**

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

WATER DEMAND AND WATER QUALITY **9 hours**

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues

GREEN CO-RATING **9 hours**

Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies Of Green Co-Rating – Case studies in Green Manufacturing

Theory: 45 **Tutorial: 0** **Practical:0** **Project: 0** **Total: 45 hours**

References:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006
5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

U18MEE0025 PRODUCT LIFECYCLE MANAGEMENT

L	T	P	J	C
2	0	2	0	3

Course outcomes:

CO1: Apply concepts of product lifecycle management and visioning

CO2: Apply relative importance of product concepts, processes and workflow

CO3: Apply principles of collaborative product development

CO4: Outline considerations in system architecture understand the industrial process

CO5: Apply product lifecycle management strategy and assessment

CO6: Apply the infrastructure assessment, assessment of current systems and applications.

Pre-requisite: U18MEE0024 Product Design and Development

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M		M					W			M	
CO2			M										M	
CO3	M		M										M	
CO4			S			W				M	M		M	
CO5			S		M	M								S
CO6						M							M	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation 5. End semester exam	Course end survey

INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT 6 Hours

Definition, PLM Lifecycle Model, Threads of Product Lifecycle Management, Need for Product Lifecycle Management, Opportunities and Benefits of Product Lifecycle Management, Views, Components and Phases of Product Lifecycle Management, Product Lifecycle Management feasibility study, Product Lifecycle Management Visioning.

PLM CONCEPTS, PROCESSES AND WORKFLOW 6 Hours

Characteristics of Product Lifecycle Management, Environment Driving Product Lifecycle Management, Product Lifecycle Management Elements, Drivers of Product Lifecycle Management, Conceptualization, Design, Development, Validation, Production, Support of Product Lifecycle Management.

COLLABORATIVE PRODUCT DEVELOPMENT 6 Hours

Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Bill of Materials and Process Consistency, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.

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SYSTEM ARCHITECTURE **6 Hours**

Introduction, Types of Product Data, Product Lifecycle Management systems, Features of Product Lifecycle Management System, System architecture, Product information models, Functionality of the Product Lifecycle Management Systems

DEVELOPING A PLM STRATEGY AND ASSESSMENT **6 Hours**

Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.

PRACTICAL: **30 Hours**

1. Streamline collaboration to capture and manage the creation, revision, release of CAD data simulation models and documentations
2. Create, assign and mange task, setting priorities of task to the teams on track,
3. Resolving issues (issue management)
4. View and markup complex 3D product design
5. Change management capabilities
6. Customization and implementation of various industrial practices
7. Conceptualization for Product Lifecycle Management
8. Validation for Product Lifecycle Management
9. Building Product information models

Theory: 30	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 60 Hours**

REFERENCES:

1. Michael Grieves, Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Mc Graw Hill, 2015.
2. Martin Eigner, System Lifecycle Management – Engineering Digitalization (Engineering 4.0), Springer Vieweg 2021.
3. Karl Ulrich,T, Steven Eppinger, D, "Product Design and Development", McGrawHill, 2015.
4. Chitale, AK, Gupta, RC, "Product Design and Manufacturing" PHI, 2013.
5. Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, "Product Design for Manufacture and Assembly", CRC Press, 2011.

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Nano Program in

New Product Development (NPD) and Product Life Cycle Management (PLM)

Optional Elective Courses with credits and Non CGPA

Approved by BoS Chairman

U18MEE0033	PRODUCT DESIGN AND MANUFACTURING	L	T	P	J	C
		2	0	2	0	3

COURSE OUTCOMES

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

CO1: Apply concepts of product development and outline product planning process.
CO2: Apply relative importance of customer needs in establishing product specifications.
CO3: Apply the principles of tolerance in Manufacturing.
CO4: Assess the significance of the selection of datum & datum features.
CO5: Apply MMC, LMC and RFS concepts.
CO6: To define the principles of optimum design.

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M		M					W			M	
CO2			M										M	
CO3	M		M										S	
CO4			S			W				M	M		M	
CO5			S		M	M								S
CO6					M				M		S			S

DIRECT
1. Continuous Assessment Test I, II 2. Assignment, Group Presentation 3. End Semester Examination
INDIRECT
2. Course End Survey

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING	**6 Hours**
Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.	
IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS	**6 Hours**
Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.	

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INTRODUCTION TO GD&T	6 Hours
Introduction to Geometric Dimensioning and Tolerancing, Scope, Definitions, and General Dimensioning, General Tolerancing and Related Principles, Symbology, Datum Referencing, Tolerances of Location, Tolerances of Form, Profile, Orientation, and Runout.	
DATUM FEATURES, MMC, LMC, RFS & CAD	**6 Hours**
Material Condition, Modifiers, radius and controlled radius, Datum plane, Datum Feature, Datum Feature Simulators, MMC, LMC & RFS: Maximum Material Condition, Least Material Condition, Regardless of Feature Size, Introduction to Tolerance Stack-Up Analysis.	
APPLICATIONS OF COMPUTER AIDED DESIGN	**6 Hours**
Basic concepts of CAD, design for manufacture and assembly, principles of computer-aided engineering, application of CAD.	
PRACTICAL	**30 Hours**
1. CAD Drafting of Flange coupling with GD&T Symbols 2. Drafting of Plummer block assembly with GD&T Symbols 3. Drafting of knuckle joint assembly using geometrical tolerance 4. Reverse Engineering of Shaft and Key Assembly 5. Preparation of Bill of Materials of Spigot and Cotter Joint.	

Theory: 30	Tutorial: 0	Practical: 30	Project: 0	Total :60 Hours

REFERENCES

1	Karl Ulrich,T, Steven Eppinger, D, "Product Design and Development", McGrawHill, 2015.
2	Chitale, AK, Gupta, RC, "Product Design and Manufacturing" PHI, 2013.
3	Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, "Product Design for Manufacture and Assembly", CRC Press, 2011
4	Gene R. Cogorno "Geometric Dimensioning and Tolerancing for Mechanical Design", McGraw-Hill,2016
5	Bryan R. Fischer "Mechanical Tolerance Stackup and Analysis" Advanced Dimensional Management, Sherwood, Oregon, U.S.A., Marcel Dekker, Inc.
6	Groover M P, "Automation, Production System and Computer Aided Manufacture", Prentice Hall, 1984.
7	Ibrahim Zeid, "CAD/CAM Theory and Practice", McGraw-Hill, 1991
8	Gene R. Cogorno "Geometric Dimensioning and Tolerancing for Mechanical Design", McGraw-Hill,2006.

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18MEE0034	PRODUCT DATA AND PRODUCT LIFECYCLE MANAGEMENT	L	T	P	J	C
		2	0	2	0	3

COURSE OUTCOMES

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

CO1: Apply concepts of product lifecycle management.
CO2: Apply the significance of product lifecycle process and workflow.
CO3: Implement the principles of collaborative product development.
CO4: Outline the major factors in system architecture.
CO5: Explain product lifecycle management strategy and assessment.
CO6: Discuss the infrastructure assessment, assessment of current systems and applications.

CO/PO Mapping
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	M		M		M					W			M	
CO2			M										M	
CO3	M		M										M	
CO4			S			W				M	M		M	
CO5			S		M	M								S
CO6						M							M	

DIRECT
1. Continuous Assessment Test I, II 2. Assignment, Group Presentation 3. End Semester Examination
INDIRECT
1. Course End Survey

OVERVIEW - PRODUCT LIFE CYCLE MANAGEMENT	**6 Hours**
Concept, PLM Lifecycle Model, Threads, Vital factors, Opportunities and Impacts of Product Lifecycle management, Components and Phases of Product Lifecycle management, Product Lifecycle Management feasibility study.	

PLM - PROCESS AND WORKFLOW	**6 Hours**
Characteristics and Environment of PLM, Driving factors for Product Lifecycle Management, Elements and Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of Product Lifecycle Management.	
COLLABORATIVE PRODUCT DEVELOPMENT	**6 Hours**
Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Bill of Materials and Process Consistency, Digital Mock-Up, Prototype Development, Virtual Testing and Validation, Marketing Collateral.	

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SYSTEM ARCHITECTURE	6 Hours
Definition, Product Data and its types, Product Lifecycle Management systems, Elements of Product Lifecycle Management System, System architecture, Product information models, Functionality of PLM Systems.	
PLM STRATEGY AND ASSESSMENT	**6 Hours**
Strategy – Definition, impact and implementation, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.	
PRACTICAL	**30 Hours**
1. Streamline collaboration to capture and manage the creation, revision, release of CAD data simulation models and documentations 2. Create, assign and mange task, setting priorities of task to the teams on track, 3. Resolving issues (issue management) 4. View and markup complex 3D product design 5. Change management capabilities 6. Customization and implementation of various industrial practices 7. Conceptualization for Product Lifecycle Management 8. Validation for Product Lifecycle Management 9. Building Product information models	

Theory: 30	Tutorial: 0	Practical: 30	Project: 0	Total :60 Hours

REFERENCES

1	Michael Grieves, Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Mc Graw Hill, 2015.
2	Martin Eigner, System Lifecycle Management – Engineering Digitalization (Engineering4.0), Springer Vieweg 2021.
3	Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGrawHill,2015.
4	Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013.
5	Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, “Product Design forManufacture and Assembly”, CRC Press, 2011.

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U18MEP6703	PROJECT WORK	L	T	P	J	C
		0	0	0	4	3

COURSE OUTCOMES

At the end of this course, the student will be able to:

CO1: Identify a Product design and development problem from the society.
CO2: Conduct systematic investigations, apply tools and develop solutions.
CO3: Demonstrate awareness of safety, professional ethics, and concerns for environment and society.
CO4: Communicate effectively through oral means and documentations.
CO5: Manage projects with considerations of time and finance.
CO6: Develop a team and contribute as a member and or as a leader.

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	PROGRAMME OUTCOMES (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S		S								S	S	S
CO2	S		S	S	S							S	S	S
CO3						S	S	S				S		
CO4									S	S				
CO5											S	S		
CO6									S	S				

- ➢ The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design, manufacture of a device, experimentation, simulation of systems.
- ➢ The work can be an innovative improvement of existing system and shall include modelling, design, experimentation, evaluation, fabrication and or analysis.
- ➢ Suitable methodology to be arrived by evaluating existing solutions.
- ➢ Suitable modern tools shall be used to find the solution.
- ➢ Every project work shall have a guide who is a faculty member of the institution.
- ➢ For industrial projects, a supervisor from the organization will be a co-guide.
- ➢ The project period allotted shall be utilized by the students to receive directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and to present periodical seminars on the progress made in the project.
- ➢ Continuous assessment shall be made as prescribed in the regulations.

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- The progress of the project will be evaluated based on a minimum of three reviews.
- Review committee will be constituted by the Head of Department.
- Each student shall finally submit a report covering background information, literature survey, problem statement, methodology and use of modern tools within the stipulated date.

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U18MEP7704	INTERNSHIP AND DOCUMENTATION	L	T	P	J	C
		0	0	0	2	0

CO 1: Develop communication, interpersonal and other critical skills to meet the requirements of interview process.
CO 2: Apply ethical principles and norms of engineering practice in the Industrial Environment
CO 3: Communicate and collaborate effectively and appropriately within the team and outside the team
CO 4: Solve real life challenges in the workplace by analyzing work environment and conditions, and selecting appropriate skill sets acquired from the course
CO 5: Acquire employment contacts leading directly to a full-time job following graduation from college.
CO 6: Develop work habits and attitudes necessary for job success

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	S	M	W						M				S	S
CO2	S	M	W						M				S	S
CO3	S	M	W						M				S	S
CO4	S	M	W						M				S	S
CO5	S	M	W						M				S	S
CO6	S	M	W						M				S	S

Students are expected to undergo 4 weeks of Industrial internship during their sixth semester. At the end of the internship, they are expected to submit report similar to the Project report, which will be evaluated by the panel composed of members nominated by the Head of the Department with the approval of CoE. In case a student score “RA” grade in Internship course then he/she must repeat the internship.

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