GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

Curriculum and Syllabus For

B. E. DEGREE PROGRAMME FOR WORKING PROFESSIONALS

(MECHANICAL ENGINEERING)

2025

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS

GOVERNMENT COLLEGE OF TECHNOLOGY

THADAGAM ROAD, COIMBATORE - 641 013

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GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E. MECHANICAL ENGINEERING

(For Working Professionals)

2025 REGULATIONS

FIRST SEMESTER

Sl. No.	Course Code	Course Title	CA Marks	End Sem Marks	Total Marks	Hours/Week			
						L	T	P	C
THEORY									
1	25WPM1Z1	Applied Mathematics I (Common to CIVIL, EEE & ECE Branches)	40	60	100	3	0	0	3
2	25WPM1Z2	Environmental Sciences and Engineering (Common to CIVIL, EEE & ECE Branches)	40	60	100	3	0	0	3
3	25WPM103	Applied Engineering Mechanics	40	60	100	3	0	0	3
4	25WPM104	Manufacturing Technology	40	60	100	3	0	0	3
PRACTICAL									
5	25WPM105	Manufacturing Technology Laboratory	60	40	100	0	0	3	1.5
Total			**220**	**280**	**500**	**12**	**0**	**3**	**13.5**

SECOND SEMESTER

Sl. No.	Course Code	Course Title	CA Marks	End Sem Marks	Total Marks	Hours/Week			
						L	T	P	C
THEORY									
1	25WPM2Z1	Applied Mathematics II (Common to EEE & ECE Branches)	40	60	100	3	0	0	3
2	25WPM202	Solid Mechanics	40	60	100	3	0	0	3
3	25WPM203	Applied Thermal Engineering	40	60	100	3	0	0	3
4	25WPM204	Basics of Electrical and Electronics Engineering	40	60	100	3	0	0	3
PRACTICAL									
5	25WPM205	Thermal Engineering Laboratory I	60	40	100	0	0	3	1.5
Total			**220**	**280**	**500**	**12**	**0**	**3**	**13.5**

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THIRD SEMESTER

Sl. No.	Course Code	Course Title	CA Marks	End Sem Marks	Total Marks	Hours/Week			
						L	T	P	C
THEORY									
1	25WPM301	Fluid Mechanics and Hydraulic Machinery	40	60	100	3	0	0	3
2	25WPM302	Kinematics of Machines	40	60	100	3	0	0	3
3	25WPM303	Heat and Mass Transfer	40	60	100	3	0	0	3
4	25WPM304	Materials Engineering and Metallurgy	40	60	100	3	0	0	3
PRACTICAL									
5	25WPM305	Thermal Engineering Laboratory II	60	40	100	0	0	3	1.5
Total			**220**	**280**	**500**	**12**	**0**	**3**	**13.5**

FOURTH SEMESTER

Sl. No.	Course Code	Course Title	CA Marks	End Sem Marks	Total Marks	Hours/Week			
						L	T	P	C
THEORY									
1	25WPM401	Dynamics of Machines	40	60	100	3	0	0	3
2	25WPM402	Metrology and Measurements	40	60	100	3	0	0	3
3	25WPM403	Refrigeration and Air Conditioning	40	60	100	3	0	0	3
4	25WPM4EX	Elective I	40	60	100	3	0	0	3
PRACTICAL									
5	25WPM404	Automation Laboratory	60	40	100	0	0	3	1.5
Total			**220**	**280**	**500**	**12**	**0**	**3**	**13.5**

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FIFTH SEMESTER

Sl. No.	Course Code	Course Title	CA Marks	End Sem Marks	Total Marks	Hours/Week			
						L	T	P	C
THEORY									
1	25WPM501	Design of Machine Elements	40	60	100	3	0	0	3
2	25WPM502	Lean Manufacturing	40	60	100	3	0	0	3
3	25WPM503	Power Plant Engineering	40	60	100	3	0	0	3
4	25WPM504	Operations Research	40	60	100	3	0	0	3
5	25WPM5EX	Elective II	40	60	100	3	0	0	3
Total			**200**	**300**	**500**	**15**	**0**	**0**	**15**

SIXTH SEMESTER

Sl. No.	Course Code	Course Title	CA Marks	End Sem Marks	Total Marks	Hours/Week			
						L	T	P	C
THEORY									
1	25WPM601	Design of Transmission Systems	40	60	100	3	0	0	3
2	25WPM602	Finite Element Analysis	40	60	100	3	0	0	3
3	25WPM603	Industry 4.0	40	60	100	3	0	0	3
4	25WPM604	Industrial Robotics	40	60	100	3	0	0	3
5	25WPM6EX	Elective III	40	60	100	3	0	0	3
Total			**200**	**300**	**500**	**12**	**0**	**0**	**15**

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SEVENTH SEMESTER

Sl. No.	Course Code	Course Title	CA Marks	End Sem Marks	Total Marks	Hours/Week			
						L	T	P	C
THEORY									
1	25WPM701	Total Quality Management	40	60	100	3	0	0	3
2	25WPM7EX	Elective IV	40	60	100	3	0	0	3
PRACTICAL									
3	25WPM702	Project Work	60	40	100	0	0	16	8
Total			**230**	**270**	**500**	**6**	**0**	**16**	**14**

TOTAL NO. OF CREDITS: 98

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E. MECHANICAL ENGINEERING

(For Working Professionals)

2025 REGULATIONS

LIST OF ELECTIVES									
Sl. No.	**Course Code**	**Course Title**	**CA Marks**	**End Sem Marks**	**Total Marks**	**Hours/Week**			
						L	**T**	**P**	**C**
ELECTIVE I									
1	25WPM4E1	Additive Manufacturing Techniques	40	60	100	3	0	0	3
2	25WPM4E2	Mechatronics	40	60	100	3	0	0	3
3	25WPM4E3	Automobile Engineering	40	60	100	3	0	0	3
4	25WPM4E4	Composite Materials	40	60	100	3	0	0	3
5	25WPM4E5	Industrial Engineering	40	60	100	3	0	0	3
ELECTIVE II									
6	25WPM5E1	Process Planning and Cost Estimation	40	60	100	3	0	0	3
7	25WPM5E2	Design of Jigs, Fixtures and Press Tools	40	60	100	3	0	0	3
8	25WPM5E3	Product Design and Development	40	60	100	3	0	0	3
9	25WPM5E4	Gas Dynamics and Jet Propulsion	40	60	100	3	0	0	3
10	25WPM5E5	Welding Technology	40	60	100	3	0	0	3
ELECTIVE III									
11	25WPM6E1	Hydraulics and Pneumatic Controls	40	60	100	3	0	0	3
12	25WPM6E2	Computer Aided Design and Manufacturing	40	60	100	3	0	0	3
13	25WPM6E3	Non-Conventional Energy Sources	40	60	100	3	0	0	3
14	25WPM6E4	Computational Fluid Dynamics	40	60	100	3	0	0	3
15	25WPM6E5	Drone Technologies	40	60	100	3	0	0	3
ELECTIVE IV									
16	25WPM7E1	Non-traditional Machining Processes	40	60	100	3	0	0	3
17	25WPM7E2	Machine Learning for Intelligent Systems	40	60	100	3	0	0	3
18	25WPM7E3	Hybrid and Electric Vehicle Technology	40	60	100	3	0	0	3
19	25WPM7E4	Green Supply Chain Management	40	60	100	3	0	0	3
20	25WPM7E5	Entrepreneurship Development	40	60	100	3	0	0	3

25WPM1Z1	APPLIED MATHEMATICS I (Common to CIVIL, EEE & ECE Branches)	SEMESTER I			
PREREQUISITES		**L**	**T**	**P**	**C**
NIL		**3**	**0**	**0**	**3**
Course Objectives	This course mainly deals with topics such as linear algebra, single variable calculus and numerical methods and plays an important role in the understanding of engineering science.				
UNIT – I	**LINEAR ALGEBRA**	**(9 Periods)**			
Consistency of System of Linear Equations, Eigen values and eigenvectors, Diagonalization of matrices by orthogonal transformation, Cayley-Hamilton Theorem, Quadratic form to canonical forms.					
UNIT – II	**DIFFERENTIAL CALCULUS**	**(9 Periods)**			
Radius of curvature, Centre of curvature, Circle of curvature, Evolutes of a curve, Envelopes.					
UNIT – III	**INTEGRAL CALCULUS**	**(9 Periods)**			
Evaluation of definite and improper integrals, Applications: surface area and volume of revolution (Cartesian coordinates only).					
UNIT – IV	**NUMERICAL SOLUTION OF EQUATIONS**	**(9 Periods)**			
Algebraic and Transcendental equation: Fixed point iteration method, Bisection method, Newton- Raphson method, Simultaneous equation: Gauss elimination method, Gauss-Jordan method, Gauss Seidal method.					
UNIT – V	**NUMERICAL INTERPOLATION**	**(9 Periods)**			
Equal interval: Newton's forward and Backward difference interpolation formulae, Gauss forward and Backward difference interpolation formulae, Unequal interval: Lagrange's interpolation, Newton's divided difference interpolation.					
Contact Periods: **Lecture: 45 Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods**					

TEXT BOOKS:

1	*Veerarajan T.,* ***"Engineering Mathematics I"****, Tata McGraw-Hill Education(India)Pvt. Ltd, New Delhi, 2015.*
2	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***"Numerical Methods"****, S. Chand & Company, 3rd Edition, Reprint 2013.*

REFERENCES:

1	*B.S.Grewal,* ***Higher Engineering Mathematics****, Khanna Publishers, 44th Edition, 2017.*
2	*David C.Lay,* ***"Linear Algebra and Its Application"****, Pearson Publishers, 6th Edition, 2021.*
3	*Howard Anton,* ***"Elementry Linear Algebra"****, 11th Edition, Wiley Publications, 2013.*
4	*Narayanan.S and Manicavachagom Pillai. T.K.,* ***"CalculasVol I and Vol II"****, S.chand & Co, 6th Edition, 2014.*
5	*S.S. Sastry, "****Introductory methods of numerical analysis"****, PHI, New Delhi, 5th Edition, 2015.*
6	*Jain R.K. and Iyengar S.R.K.,* ***"Advanced Engineering Mathematics"****, Narosa Publications, 8th Edition, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use the essential tool of matrices and linear algebra in a comprehensive manner.	K3
CO2	Explain the fallouts of circle of curvature, evolute and envelops that is fundamental to application of analysis to Engineering problems.	K3
CO3	Interpret the integral calculus to notions of definite and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.	K3
CO4	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to polynomial and transcendental equations.	K3
CO5	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations.	K3

25WPM1Z2	ENVIRONMENTAL SCIENCES AND ENGINEERING (Common to CIVIL, EEE & ECE Branches)	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	The course is aimed at creating awareness among the students and also inseminates the critical ideas of preserving environment.

UNIT – I	ENVIRONMENTAL ENERGY RESOURCES	(9 Periods)

Food-effects of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications-Energy resources: renewable resources - Hydro Energy, Solar & Wind. Non-renewable resources – Coal and Petroleum - harnessing methods.

UNIT – II	ECO SYSTEM AND BIODIVERSITY	(9 Periods)

Eco system and its components - biotic and abiotic components. Biodiversity: types and values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity: In situ and ex situ conservation. Threats to biodiversity-destruction of habitat, habit fragmentation, hunting, over exploitation and man-wildlife conflicts. The IUCN red list categories.

UNIT – III	ENVIRONMENTAL POLLUTION	(9 Periods)

Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants SO_2, NO_2, H_2S, CO, CO_2 and particulates. Water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollution. Noise pollution - decibel scale, sources, effects and control.

UNIT – IV	ENVIRONMENTAL THREATS	(9 Periods)

Global warming-measure to check global warming - impacts of enhanced Greenhouse effect, Acid rain- effects and control of acid rain, ozone layer depletion- effects of ozone depletion, disaster management - flood, drought, earthquake and tsunami.

UNIT – V	SOCIAL ISSUES AND ENVIRONMENT	(9 Periods)

Water conservation, rain water harvesting, e-waste management, Pollution Control Act, Wild life Protection Act. Population growth- exponential and logistic growth, variation in population among nations, population policy. Women and Child welfare programs. Role of information technology in human and health, COVID-19 - effects and preventive measures.

Contact Periods:

Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods

TEXT BOOKS:

1	*Sharma J.P., **"Environmental Studies"**, 4th Edition, University Science Press, New Delhi, 2016.*
2	*Anubha Kaushik and C.P.Kaushik, **"Environmental Science and Engineering"**, 7th Edition, New age international publishers, New Delhi, 2021.*

REFERENCES:

1	*A k de, **"Environmental Chemistry"**, 8th edition, New age international publishers, 2017.*
2	*G. Tyler miller and scott e. Spoolman, **"Environmental Science"**, cengage learning india pvt. Ltd., delhi, 2014.*
3	*Erach Bharucha, **"Textbook of Environmental Studies"**, Universities press (I) pvt, Ltd., Hydrabad, 2015.*
4	*Gilbert M . Masters, **"Introduction to Environmental Engineering and Science"**, 3rd Edition, Pearson Education, 2015.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize and understand about the various environmental energy resources and the effective utility of modern agriculture.	K2
CO2	Acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.	K2
CO3	Be aware of the sources of various types of pollution, their ill effects and preventive methods.	K2
CO4	Identify and take the preventive measures to control the environmental threats and effects of Global warming, Ozone depletion, Acid rain, and natural disasters.	K2
CO5	Demonstrate an idea to save water and other issues like COVID -19.	K2

25WPM103	APPLIED ENGINEERING MECHANICS	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To study the forces and moments in various types of mechanical systems and to enable students to understand the relationship between processes, kinetics and kinematics.

UNIT – I	INTRODUCTION TO MECHANICS AND FORCE CONCEPTS	(9 Periods)

Principles and Concepts – Laws of Mechanics – system of forces – resultant of a force system – resolution and composition of forces – Lami's theorem – moment of a force – physical significance of moment-Varignon's theorem – resolution of a force into force and couple – forces in space – addition of concurrent forces in space – equilibrium of a particle in space, Classification of beams based on supports.

UNIT – II	FRICTION	(9 Periods)

Frictional resistance – classification of friction- laws of friction – coefficient of friction- angle of friction – angle of repose — cone of friction – free body diagram-advantages- equilibrium of a body on a rough inclined plane – non-concurrent force system - ladder friction – rope friction – wedge friction.

UNIT – III	GEOMETRICAL PROPERTIES OF SECTION	(9 Periods)

Centroids – Determination by integration – centroid of an area – simple figures - composite sections – bodies with cut parts - moment of inertia – theorems of moment of inertia – moment of inertia of composite sections – principal moment of inertia of plane areas - radius of gyration.

UNIT – IV	BASICS OF DYNAMICS	(9 Periods)

Kinematics and kinetics – displacements, velocity and acceleration - Equations of motion – Rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration – motion curves – motion under gravity – relative motion – curvilinear motion of particles – projectiles – angle of projection – range – time of flight and maximum height. Newton's second law of motion – linear momentum – D'Alembert's principle, Dynamics equilibrium — work energy equation of particles– law of conservation of energy – principle of work and energy.

UNIT – V	IMPULSE MOMENTUM AND IMPACT OF ELASTIC BODIES	(9 Periods)

Principle of impulse and momentum – Equations of momentum – Laws of conservation of momentum. Impact – Time of compression, restitution, collision – Co-efficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – collision of small body with a massive body – Kinetic energy of a particle.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*S.S. Bhavikatti and K.G. Rajasekarappa,* ***"Engineering Mechanics"****, New age international (P) ltd, 1999.*
2	*S.C. Natesan,* ***"Engineering Mechanics"*** *Umesh Publications, 2005.*

REFERENCES:

1	*F.B. Beer and E.R. Johnson,* ***"Vector Mechanics for Engineers"****, Tata McGraw Hill Pvt. Ltd, 10th Edition, 2013.*
2	*S. Timoshenko, D.H.Young, J.V.Rao and Sukumar Pati,* ***"Engineering Mechanics"****, McGraw Hill Education, 5th Edition, 2017.*
3	*Irving Shames and Krishna Mohana Rao,* ***"Engineering Mechanics"****, Prentice Hall of India Ltd, Delhi, 2006.*
4	*R.C. Hibbeller,* ***"Engineering Mechanics"****, Prentice Hall of India Ltd, 13th Edition, 2013.*
5	*Vela Murali,* ***"Engineering Mechanics",*** *Oxford university Press, 1st Edition, 2010.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the concept of mechanics and system of forces and moments.	K5
CO2	Calculate the frictional properties at different bodies.	K5
CO3	Identify the locations of centre of gravity and moment of inertia for different sections.	K5
CO4	Understand the basics of dynamics of particles	K5
CO5	Know the impulse and momentum principle and impact of elastic bodies.	K5

25WPM104	MANUFACTURING TECHNOLOGY	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To acquire knowledge about various types of manufacturing processes this includes casting, joining, forming and conventional machining to produce a product for competitive industrial applications.

UNIT – I	METAL CASTING AND JOINING PROCESSES	(9 Periods)

Introduction to Concepts of Manufacturing Process -Sand casting – Sand moulds - Type of patterns – Pattern materials – Pattern allowances – Core making – Special casting processes: Investment casting, die casting. Fusion welding – Types – Gas welding - Shielded metal arc welding - Gas metal arc welding - Gas tungsten arc welding - Submerged arc welding – Electro slag welding - Principles of resistance welding – Spot, butt, seam, projection and percussion welding.

UNIT – II	BULK DEFORMATION AND SHEET METAL FORMING	(9 Periods)

Hot working and cold working of metals – Forging processes – Open and close die forging – Types of forging machines - Forging operations – Mechanism of rolling – Types of Rolling mills – Principles of Extrusion – Typical shearing operations, bending and drawing operations - Metal spinning.

UNIT – III	THEORY OF METAL CUTTING	(9 Periods)

Mechanics of chip formation – forces in machining – types of chips – cutting tools – single point cutting tool nomenclature – orthogonal and oblique metal cutting – thermal aspects – cutting tool materials – tool wears – tool life – surface finish – cutting fluids and machinability.

UNIT – IV	LATHE, SHAPING, PLANING AND DRILLING MACHINES	(9 Periods)

Lathe – construction – types – operations – working principle of single and multi - spindle automats – shaping and planning machines – principle – types – construction - mechanism – different shaping operations – work holding devices - Drilling machines – types, operations – drill tool nomenclature.

UNIT – V	GRINDING AND MILLING MACHINES	(9 Periods)

Grinding – types of grinding machines – grinding wheels, specifications – bonds – mounting and reconditioning of grinding wheels - Milling – types - cutter nomenclature – types of cutters – milling processes – indexing – gear generation - gear shaping and gear hobbing – gear finishing methods.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*P. N. Rao,* ***"Manufacturing Technology: Foundry, Forming and Welding"****, McGraw Hill, 5th Edition, 2018.*
2	*P.N. Rao,* ***"Manufacturing Technology Vol II: Metal Cutting and Machine Tools"****, McGraw Hill Education, 4th Edition, 2018.*

REFERENCES:

1	*Serope Kalpakjian and Steven R. Schmid,* ***"Manufacturing Engineering and Technology"****, Pearson Education, 7th Edition, 2018.*

2	*P. C. Sharma,* ***"A Text book of Production Technology"****, S. Chand and Co. Ltd., 2021.*
3	*S. K. Hajra Choudhry, and Nirjhar Roy and A. K. Hajra Choudhury,* ***"Elements of Workshop Technology Vol II: Machine Tools"****, Media Promoters and Publishers Pvt. Ltd., 2018.*
4	*R.K. Rajput,* ***"Manufacturing Technology"****, Laxmi Publication Pvt Ltd, 2nd Edition, 2007.*
5	*Mikell P. Groover,* ***"Fundamentals of Modern Manufacturing: Materials, Processes, and System"****, John Wiley and Sons, 2010.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the principle of metal casting and welding processes for engineering applications.	K3
CO2	Identify the suitable forging, rolling and metal forming processes.	K3
CO3	Apply the theory of metal cutting to solve the problems in industries.	K3
CO4	Understand the operating mechanism of lathe, shaping, planning and drilling machines.	K3
CO5	Familiarize the grinding, milling and gear generation process and its uses in industries.	K3

25WPM105	MANUFACTURING TECHNOLOGY LABORATORY	SEMESTER I

PREREQUISITES	L	T	P	C
NIL	0	0	3	1.5

Course Objectives	To provide an understanding of advanced manufacturing methods with idea of the dimensional and form accuracy of products.

LIST OF EXPERIMENTS

1. Facing, Step Turning, Taper Turning using Lathe.
2. External Thread Cutting. Groove Cutting, Knurling and Chamfering using Lathe.
3. Drilling and Counter Sinking using Lathe.
4. Drilling, Reaming, Tapping and Surface Grinding using Surface Grinder and Radial Drilling Machine.
5. External Cylindrical Grinding of Shaft.
6. V-Groove Cutting in Shaping Machine.
7. Spur Gear Milling.
8. Helical Gear Milling in Universal Milling Machine.
9. Gear Shaping.
10. Gear Hobbing.
11. Making Hexagonal Hole using Slotting Machine.
12. Letter Cutting in Vertical Milling Machine.
13. CNC Part Programming for Machining of Facing, Step Turning, Taper Turning, Milling in CNC machine.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Have the capability of selecting suitable manufacturing processes to manufacture the products optimally.	K2
CO2	Maintain the accuracy and tolerance of components produced.	K4
CO3	Set up machines like lathe, shaper, grinding and milling machine for various applications.	K2
CO4	Prepare gears using forming and generating methods of gear manufacturing.	K3
CO5	Write the part programming and perform machining in CNC Machines.	K4

25WPM2Z1	APPLIED MATHEMATICS II (Common to EEE & ECE Branches)	SEMESTER II			
PREREQUISITES		**L**	**T**	**P**	**C**
NIL		**3**	**0**	**0**	**3**
Course Objective	To focus on differential equations and numerical techniques which is important for comprehending engineering science.				
UNIT – I	**ORDINARY DIFFERENTIAL EQUATIONS**	**(9 Periods)**			
Higher order linear differential equations with constant coefficients -variable coefficients: Cauchy-Euler equation, Cauchy-Legendre equation-Method of variation of parameters.					
UNIT – II	**PARTIAL DIFFERENTIAL EQUATIONS**	**(9 Periods)**			
Formation of partial differential equations – First order partial differential equations – Standard types and Lagrange's linear equation – Homogeneous linear partial differential equations of second and higher order with constant coefficients.					
UNIT– III	**NUMERICAL DIFFERENTIATION AND INTEGRATION**	**(9 Periods)**			
Numerical Differentiation (using Newton's interpolation formula) – Numerical integration: Trapezoidal rule and Simpson's rules (Both single and double integrals.					
UNIT – IV	**NUMERICAL SOLUTION OF FIRST ORDINARY DIFFERENTIALEQUATIONS**	**(9 Periods)**			
Single Step Methods : Taylor's series method-Euler's and modified Euler's methods-Runge-Kutta method of fourth order Multi Step methods - Milne's and Adam's predicator-corrector Methods.					
UNIT – V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**(9 Periods)**			
Finite difference solution of two dimensional Laplace equation and Poisson equation- Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods)-Finite difference explicit method for one dimensional wave equation.					
Contact Periods: **Lecture: 45 Periods Tutorial: 0Periods Practical: 0 Periods Total: 45 Periods**					

TEXT BOOKS:

1	*Veerarajan.T.,* ***"Engineering Mathematics"****, McGraw Hill Education, 2019.*
2	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***"Numerical Methods"****, S. Chand & Company, Revised Edition, 2017.*

REFERENCES:

1	*B.S.Grewal,* ***"Higher Engineering Mathematics"****, Khanna Publishers, 45th Edition, 2024.*
2	*Srimanta Pal,* ***"Numerical Methods Principles, Analyses and Algorithms"****, Oxford University Press, 1st Edition, 2009.*
3	*Raisinghania. M. D.,* ***"Ordinary and Partial Differential Equations"****,S. Chand Publishing, 20th Edition, 2024.*
4	*S.S. Sastry,* ***"Introductory Methods of Numerical Analysis"****, PHI, New Delhi, 5th Edition, 2015.*
5	*S.Larsson and V.Thomee,* ***"Partial Differential Equations with Numerical Methods"****, Springer, 2nd edition 2008.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Obtain the knowledge for solving higher order linear differential equation with constant and variable coefficient techniques and simultaneous differential equation.	K3
CO2	Understand the knowledge of partial differential equations (PDEs), modeling; demonstrate accurate and efficient use of Lagrange's techniques.	K3
CO3	Demonstrate and understanding of common numerical methods and how they are used to obtain approximate solutions to polynomial and transcendental equations.	K3
CO4	Construct one-step and linear multistep methods for the numerical solution of initial-value problems for ordinary differential equations.	K3
CO5	Acquire the knowledge of principles for designing numerical schemes for PDEs in particular finite difference schemes.	K3

25WPM202	SOLID MECHANICS	SEMESTER II			
PREREQUISITES		**L**	**T**	**P**	**C**
NIL		**3**	**0**	**0**	**3**
Course Objective	To learn the basics techniques to evaluate stresses, strain, bending moment and shear force distribution in engineering structures.				
UNIT – I	**STRESS AND STRAIN**				**(9 Periods)**
Tension, compression, shear stresses - Hooke's law - Compound bars – lateral strain - Poisson's ratio -Volumetric strain - Bulk modulus - Relationship among elastic constants – stress strain diagrams- Ultimate stress - Yield stress-Factor of safety - Thermal stresses - Strain energy due to axial force - Resilience - Stress due to gradual load, suddenly applied load and Impact load.					
UNIT – II	**SHEAR FORCE AND BENDING MOMENT**				**(9 Periods)**
Beams – Types of Beams - Types of loads, supports - Shear force – Bending moment – shear forces and bending moment diagrams for cantilever, simply supported and over hanging beams with concentrated ,uniformly distributed, uniformly varying load and couple- Point of contra flexure.					
UNIT – III	**THEORY OF BENDING AND COMPLEX STRESSES**				**(9 Periods)**
Bending equation-Section Modulus-Stress distribution at a cross section due to bending moment and shear force for cantilever, simply supported beams with point, UDL loads (Rectangular, circular, I & T sections only) - Principal stresses and Principal planes - Principal Strains - Mohr's circle of stress (Two dimension only).					
UNIT – IV	**DEFLECTION OF BEAMS AND THEORY OF LONG COLUMNS**				**(9 Periods)**
Determinations of deflection curve - Relation between slope, deflection and radius of curvature - Slope and deflection of beam at any section by Macaulay's method - Euler's theory of long Columns- Expression of crippling load for various end conditions-Effective length - Slenderness ratio - Rankine formula for columns.					
UNIT – V	**THEORY OF TORSION**				**(9 Periods)**
Torsion of shafts - Torsion equation - Polar modulus - Stresses in Solid and Hollow circular shafts - Torsional rigidity - Power transmitted by the shaft - Importance of angle of Twist - Strain energy due to Torsion -Modulus of rupture - Torsional resilience - Combined bending and Torsion - Stresses in helical springs - Deflection of helical spring.					
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**					

TEXT BOOKS:

1	*Sadhu Singh, **"Strength of Materials"**, Khana Publishers, 11th Edition, 2024.*
2	*R.K.Rajput, **"Strength of Materials"**, S. Chand & Company Ltd., 7th Edition, 2022.*

REFERENCES:

1	*S.S. Bhavikatti, **"Strength of Materials"**, Vikas Publishing House, 5th Edition, 2023.*
2	*James M.Gere and Barry J.Goodno, **"Mechanics of Materials"**, Cengage Learning India Pvt., 9th Edition, 2022.*
3	*Srinath L., **"Advanced Mechanics of Solids"**, McGraw Hill Education, 3rd Edition, 2017.*
4	*Kazimi, **"Solid Mechanics"**, McGraw Hill Education, 1st Revised Edition, 2022.*

5	*Jacob Lubliner and Panayiotis Papadopoulos,* ***"Introduction to Solid Mechanics – An Integrated Approach"****, Springer, 2014th Edition, 2013.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Evaluate stresses and strains for various types of loading.	K2
CO2	Estimate the shear force and bending moment and find the point of contraflexure.	K2
CO3	Create shear stress distribution drawings for simple sections and evaluate principal stresses and strains.	K3
CO4	Use theory of beams and long columns to find slope, deflection, radius of curvature of beams and crippling load of long columns.	K3
CO5	Apply theory of torsion for problems involving torsion of circular shafts and leaf spring.	K3

25WPM203	APPLIED THERMAL ENGINEERING (Use of Approved Steam Tables and Charts are Permitted)	SEMESTER II

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the basic laws of thermodynamics, understand the behaviour of energy and entropy in various processes and develop fundamental knowledge of thermal systems.

UNIT – I	THERMODYNAMIC LAWS AND ENTROPY	(9 Periods)

Basic concepts - Thermodynamic systems - Zeroth law of thermodynamics - First law of thermodynamics – Application to closed and open systems -Steady flow energy equation - Second law of thermodynamics –Carnot theorem, Carnot cycle, Efficiency and COP - Concept of entropy - Entropy of ideal gas - Principle of increase of entropy.

UNIT – II	STEAM POWER CYCLESAND IDEAL GAS MIXTURES	(9 Periods)

Properties of pure substances – Thermodynamic properties of steam - Dryness Fraction - Rankine cycle, Reheat and regenerative cycle and Binary vapour cycle - Maxwell's equations - Joule Thomson coefficient - Clausius Clapeyron equation -Ideal and real gas - Gas mixtures - Dalton's law of partial pressures - P-V-T behavior of gas mixtures.

UNIT – III	AIR STANDARD CYCLES AND IC ENGINES	(9 Periods)

Otto cycle, Diesel cycle, Brayton cycle and Dual cycle – Calculation of mean effective pressure and air standard efficiency - SI and CI Engines - Classification - Components - Simple carburettor – MPFI - Diesel pump and injector systems - Ignition systems -Lubrication and cooling systems - Combustion and knocking in SI and CI Engines.

UNIT – IV	COMPRESSORS AND TURBINES	(9 Periods)

Introduction - Compressor types - Reciprocating and rotary compressors - Performance of compressors - Flow through nozzles - Shape of nozzles, Effect of friction, Critical pressure ratio - Turbines - Steam and gas turbines - Impulse and reaction principles – Compounding of steam turbines.

UNIT – V	PSYCHROMETRY AND REFRIGERATION	(9 Periods)

Psychrometric processes – Sensible heating and cooling, Cooling and dehumidification, Heating and humidification, Adiabatic mixing and evaporative cooling - Methods of refrigeration- Air refrigeration systems – Refrigerants- Properties - Vapour compression refrigeration system -Vapour absorption refrigeration system.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*P. K. Nag,* ***"Engineering Thermodynamics"****, Tata McGraw Hill Company, 6th Edition, 2017.*
2	*Mahesh M. Rathore,* ***"Thermal Engineering Vol I & II"****, McGraw Hill Education, 1st Edition, 2018.*

REFERENCES:

1	*C. P. Arora,* ***"Thermodynamics"****, McGraw Hill Education, 2017.*
2	*Prasanna Kumar,* ***"Engineering Thermodynamics"****, Pearson Education India, 1st Edition,2013.*
3	*Yunus A. Cengel and Michael A. Boles.,* ***"Thermodynamics: An Engineering Approach"****,McGraw Hill Education, 9th Edition, 2019.*

4	*R. K. Rajput,* ***"Thermal Engineering"****, Lakshmi Publications, 11th Edition, 2023.*
5	*M. L. Mathur and F. S. Mehta,* ***"Thermal Science and Engineering"****, Jain Brothers, 3rd Edition, 2021.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the first and second laws of thermodynamics along with entropy concepts to analyse different thermodynamic systems.	K4
CO2	Understand the behaviour of steam under various conditions used in power generation and develop basic thermodynamic relations for ideal and real gases.	K4
CO3	Identify the key characteristics of refrigeration systems and understand the fundamental concepts of psychrometry.	K3
CO4	Analyse basic air-standard cycles and understand the working principles of IC engines.	K4
CO5	Apply thermodynamic principles to analyse air compressors, nozzles and turbines.	K3

25WPM204	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING				SEMESTER II
PREREQUISITES		**L**	**T**	**P**	**C**
NIL		**3**	**0**	**0**	**3**
Course Objectives	To study the basic concepts of electric circuits, electrical machines, analog and digital electronics, house wiring and electrical installations.				
UNIT – I	**ELECTRICAL CIRCUITS**				**(9 Periods)**
Electrical circuit elements (R,L and C) - Voltage and current sources – Ohm's Law – Kirchoff laws – Time domain analysis of first order RL and RC circuits – Representation of sinusoidal waveforms – Average, RMS and Peak values – Phasor representation – Real, reactive, apparent power and power factor.					
UNIT – II	**ELECTRICAL MACHINES AND MEASUREMENTS**				**(9 Periods)**
Construction, Principle of operation, Basic equations and types, Characteristics and applications of DC generators, DC motors, Single phase transformer, Single phase and three phase induction motor. Operating principles of moving coil, Moving iron instruments (Ammeter and Voltmeters).					
UNIT – III	**ANALOG AND DIGITAL ELECTRONICS**				**(9 Periods)**
Analog Electronics: Semiconductor devices – P-N junction diode, Zener diode, BJT, Operational amplifier –principle of operation, Characteristics and applications. Digital Electronics: Introduction to numbers systems, basic Boolean laws, reduction of Boolean expressions and implementation with logic gates.					
UNIT – IV	**FUNDAMENTAL OF COMMUNICATION ENGINEERING**				**(9 Periods)**
Types of Signals: Analog and digital signals – Modulation and demodulation: Principles of amplitude and frequency modulations – Introduction to resistive, inductive and capacitive transducers.					
UNIT – V	**ELECTRICAL INSTALLATIONS AND ENERGY CONSERVATION**				**(9 Periods)**
Single phase and three phase system – Phase, neutral and earth, basic house wiring -Tools and components, Different types of wiring - Basic safety measures at home and industry – Energy efficient lamps - Energy billing. Introduction to UPS and SMPS.					
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**					

TEXT BOOKS:

1	*R.Muthusubramaniam, R.Salivaganan, Muralidharan K.A.,* ***"Basic Electrical and Electronics Engineering"****, Tata McGraw Hill, 2nd Edition, 2024.*
2	*Mittle V.N and Aravind Mittal,* ***"Basic Electrical Engineering"****, Tata McGraw Hill, 2nd Edition, 2005.*

REFERENCES:

1	*D.P.Kothari, I.J. Nagrath,* ***"Basic Electrical and Electronics Engineering"****, Tata McGraw Hill, 2nd Edition, 2020.*
2	*Nagsarkar T.K and Sukhija M.S,* ***"Basic Electrical Engineering"****, Oxford Press, 2011.*
3	*E.Hughes,* ***"Electrical and Elecronics Technology"****, Pearson, 10th Edition, 2010.*
4	*Mohmood Nahvi and Joseph A. Edminister,* ***"Electric Circuits"****, Shaum Outline series, McGraw Hill, 1stEdition, 2020.*

5	*Premkumar N and Gnanavadivel J,* ***"Basic Electrical and Electronics Engineering"****, Anuradha Publishers, 8th Edition, 2019.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the DC and AC circuits	K4
CO2	Describe the operation and characteristics of electrical machines	K4
CO3	Classify and compare various semiconductor devices and digital electronics.	K3
CO4	Infer the concept of communication engineering and transducers.	K2
CO5	Assemble and implement electrical wiring and electrical installations	K6

25WPM205	THERMAL ENGINEERING LABORATORY I	SEMESTER II

PREREQUISITES	L	T	P	C
NIL	0	0	3	1.5

Course Objectives	To demonstrate and analyze the performance characteristics of an internal combustion engines, compressors and blowers.

LIST OF EXPERIMENTS

1. Port timing diagram of single cylinder petrol engine.
2. Valve timing diagram of single cylinder diesel engine.
3. Performance test on variable compression ratio petrol and diesel engines.
4. Economic speed test on diesel engine.
5. Retardation test to find frictional power of a diesel engine.
6. Heat balance test on 4 stroke Diesel Engine.
7. Emission test on internal combustion engine.
8. Performance test on constant speed blower.
9. Performance test on variable speed blower.
10. Performance test on reciprocating air compressor.

Contact periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the valve timing and port timing diagrams of IC engines	K2
CO2	Analyze the performance characteristics of petrol and diesel engines.	K4
CO3	Interpret the emission characteristics of internal combustion engines.	K4
CO4	Evaluate the performance parameters of blowers.	K5
CO5	Analyze the air compressor characteristics.	K4

25WPM301	FLUID MECHANICS AND HYDRAULIC MACHINERY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL		3	0	0	3

Course Objectives	To understand the Fluid properties, types of fluid flow, dimensional analysis and performance of pumps and turbines.

UNIT – I	**FLUID PROPERTIES**	**(9 Periods)**

Units and dimensions – Fluid properties – density, specific gravity, viscosity, surface tension, capillarity, compressibility and bulk modulus - Pascal's law - Pressure measurements - Manometers - Fluid statics – Total pressure and centre of pressure on submerged surfaces.

UNIT – II	**FLUID KINEMATICS AND DYNAMICS**	**(9 Periods)**

Types of fluid flow and flow lines – Control volume – Continuity equation in one dimension and three dimension - Velocity potential and stream function - Energy equation – Euler and Bernoulli's equations - Applications of energy equations - Flow meters - Laminar and turbulent flow through pipes - Hagen Poisullie equation - Darcy Weisbach formula - applications.

UNIT – III	**DIMENSIONAL ANALYSIS**	**(9 Periods)**

Need for dimensional analysis – Dimensional homogeneity – Rayleigh's and Buckingham methods of dimensional analysis – Model study and similitude – Scale effects and distorted model.

UNIT – IV	**TURBINES**	**(9 Periods)**

Classification of turbines – Construction, working principles and design of Pelton wheel, Francis and Kaplan turbines - Work done and efficiency - Specific speed - Operating characteristics - Governing of turbines.

UNIT – V	**PUMPS**	**(9 Periods)**

Classification of pumps - Working principle of Centrifugal and Reciprocating pumps – Work done and efficiency – Multistage pumps - Negative slip - Air vessels - Indicator diagram – problems.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*P.N.Modi and S.N.Seth,* ***"Hydraulics and Fluid Mechanics, Including Hydraulic Machines"****, Standard Book House, 15th Edition, 2015.*
2	*R.K.Bansal,* ***"Fluid Mechanics and Hydraulic Machines"****, Laxmi Publications (P) Ltd., 9th Edition, 2018.*

REFERENCES:

1	*K.Subramanya,* ***"Flow in Open channels"****, McGraw-Hill, 5th Edition, 2019.*
2	*S.Ramamrutham and R.Narayan,* ***"Hydraulics, Fluid Mechanics and Fluid Machines"****, Dhanpat Rai Publishing Company, 9th Edition, 2014.*
3	*R.K.Rajput,* ***"A Text Book of Fluid Mechanics and Hydraulic Machines"****, S.Chand and Company, 9th Edition, 2015.*
4	*D.S.Kumar,* ***"Fluid Mechanics and Fluid Power Engineering"****, S.K.Kataria & Sons, 9th Edition, 2018.*

5	*G.K.Batchelor,* ***"An Introduction to Fluid dynamics"****, Cambridge University Press, 2nd Edition, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain fluid properties and its applications.	K4
CO2	Gain knowledge on fluid flows and to solve practical problems.	K4
CO3	Apply the concepts of dimensional analysis for fluid flow problems.	K4
CO4	Analyze the performance of turbines and design of turbines.	K4
CO5	Analyze the performance of pumps and design of pumps.	K4

25WPM302	KINEMATICS OF MACHINES				SEMESTER III
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**3**	**0**	**0**	**3**

Course Objectives	To familiarize students with the basic of mechanisms, friction drives, to build confidence on the basics of cams, gear theory and its nomenclature.

UNIT – I	**BASICS OF MECHANISMS**	**(9 Periods)**

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

UNIT – II	**KINEMATIC ANALYSIS**	**(9 Periods)**

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 Klein's construction for slider crank chain. Synthesis of Mechanism-four bar mechanism only -Inversion method.

UNIT – III	**FRICTION DRIVES**	**(9 Periods)**

Belt and rope drive – Open and cross belt drive – Belt materials – Creep and slip - Ratio of tensions – Effect of centrifugal force – condition for maximum power – Friction in Journal Bearing - Flat pivot bearing - Friction clutches – Single plate – Multi plate – Cone clutches - Brakes - Shoe brake and Internal Expanding brake only.

UNIT – IV	**CAMS**	**(9 Periods)**

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.

UNIT – V	**GEARS**	**(9 Periods)**

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 –Simple, compound, reverted and epicyclic gear trains – Differentials. Multi speed gear boxes – Speed ratio - Kinematic arrangement – Ray diagram.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*S. S. Rattan,* ***"Theory of Machines"****, McGraw Hill Education, 5th Edition, 2019.*
2	*Thomas Bevan,* ***"Theory of Machines"****, Pearson Education India, 3rd Edition, 2010.*

REFERENCES:

1	*John J. Uicker, Gordon R. Pennock and Joseph E.Shigley,* ***"Theory of Machines and Mechanisms"****, Oxford University Press, 4th Edition, 2014.*

2	*Amitabha Ghosh and Asok K. Mallik,* ***"Theory of Mechanisms and Machines"****, East West Publishers, 2008.*
3	*J. S. Rao and R. V. Dukkipati,* ***"Mechanism and Machine Theory"****, New Age International Publishers, 2006.*
4	*R. S. Khurmi and J. K. Gupta,* ***"Theory of Machines"****, S.Chand & Company, 14th Edition, 2020.*
5	*R. L. Norton,* ***"Kinematics and Dynamics of Machinery"****, McGraw Hill Education, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the fundamental concepts in developing various mechanisms.	K2
CO2	Synthesis of mechanisms for given conditions.	K3
CO3	Select appropriate type of friction drives gear for a specific application.	K3
CO4	Construct the cam profile for specific follower motion.	K3
CO5	Determine appropriate gears for requirements. Compute the parameters in gear trains and determine the speeds in gear boxes.	K3

25WPM303	HEAT AND MASS TRANSFER *(Use of Approved Heat and Mass Transfer Data Book is permitted)*	SEMESTER III

PREREQUISITES	L	T	P	C
1. 25WPM2Z1 Applied Mathematics II **2.** 25WPM203 Applied Thermal Engineering	**3**	**0**	**0**	**3**

Course Objectives	To familiarize and appreciate different modes of heat and mass transfer and its applications by imparting knowledge on bioprocess industries, design of heat and mass transfer equipments and bio-reactors.

UNIT – I	CONDUCTION	(9 Periods)

Fundamental differential equation of heat conduction in Cartesian coordinates- representation of general heat conduction equation in cylindrical and spherical coordinates – Fourier‘s law of heat conduction – boundary and initial conditions – plane wall and radial systems – critical thickness of insulation – conduction with thermal energy generation – heat transfer from extended surfaces – transient heat conduction.

UNIT – II	CONVECTION	(9 Periods)

Principles of convection – convection boundary layer – laminar and turbulent flow – empirical relations for external and internal forced convection flows – flat plate, cylinders, spheres – empirical relations for free convection flows – horizontal cylinders, horizontal plates, vertical planes, inclined surfaces and enclosed spaces.

UNIT – III	RADIATION	(9 Periods)

Nature of thermal radiation – radiation intensity – relation to emission, irradiation and radiosity – black body radiation – loss of radiation – emissivity – surface emission – Kirchhoff‘s law – gray surface – view factor – radiation exchange between black surfaces – radiation exchange between gray surfaces – electrical analogy – radiation shields.

UNIT – IV	BOILING, CONDENSATION AND HEAT EXCHANGERS	(9 Periods)

Boiling and Condensation – regimes of boiling – forced convection boiling – Nusselt‘s theory of condensation – film wise and drop wise condensation. Heat exchanger types - overall heat transfer coefficient – fouling factors – Heat exchanger analysis: LMTD method - NTU method.

UNIT – V	MASS TRANSFER	(9 Periods)

Basic Concepts – concentration , velocities, fluxes – diffusion mass transfer – steady state molecular diffusion – convective mass transfer – analogy between convective heat and mass transfer – convective mass transfer correlations - simultaneous heat and mass transfer.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*Sachdeva R.C.,* ***“Fundamentals of Engineering Heat and Mass Transfer”****, New Age International Publishers, New Delhi, 2010*
2	*Kothandaraman C.P.,* ***“Fundamentals of Heat and Mass Transfer”****, New Age International Publishers, New Delhi, 2010.*

REFERENCES:

1	*Frank P Incropera and David P. Dewitt,* ***“Fundamentals of Engineering Heat and Mass Transfer”****, John Wiley and Sons, 2010.*
2	*Holman J.P.,* ***“Heat and Mass Transfer”****, Tata McGrawHill, 2010.*
3	*Yunus Cengel,* ***“Heat Transfer”****, McGraw Hill Company, 2008.*

4	*M. N. Ozisik,* ***"Heat Transfer"****, McGraw Hill Book Co., 2005.*
5	*R. Yadav,* ***"Heat and Mass Transfer"****, Central Publishing House, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basic modes of heat and mass transfer.	K3
CO2	Apply principles of heat and mass transfer to predict transfer coefficients	K3
CO3	Analyze working of various heat transfer equipment	K3
CO4	Design heat and mass transfer equipment.	K4
CO5	Evaluate number of stages required for given mass transfer problem.	K3

25WPM304	MATERIALS ENGINEERING AND METALLURGY	SEMESTER III

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To study the crystal structure, phase diagrams, phase transformations and heat treatment of alloys and to acquire knowledge on various testing methods of engineering materials.

UNIT – I	**BASICS OF CRYSTALS STRUCTURES**	**(9 Periods)**

Classification of engineering materials, ABAB stacking of HCP structure, ABCABC Stacking of CCP structure, Voids in closed packed structure, Dislocations, Slip systems, Deformation by twining, Twin-Tilt Boundary, Burger circuit, Stacking fault, Types of solid solutions, Hume Rotherys rules, Intermediate alloy phases and electron compounds, Solid solutions - Substitutional and interstitial.

UNIT – II	**PHASE DIAGRAMS OF ALLOYS AND STRENGTHENING MECHANISMS**	**(9 Periods)**

Unary phase diagram, Binary isomorphous and eutectic system, Iron-carbon equilibrium diagram - Experimental methods of construction of equilibrium diagrams, Invariant reactions - Eutectic, Peritectic, Eutectoid and peritectoid reactions, Strengthening mechanisms: Strengthening by grain size reduction solute hardening, cold working, strain hardening, Recovery recrystallization and grain growth.

UNIT – III	**PHASE TRANSFORMATIONS AND HEAT TREATMENT OF ALLOYS**	**(9 Periods)**

Heat treatment of steel - TTT diagram - annealing process, normalizing, hardening and tempering of steels - Austempering, martempering, Isothermal transformation diagrams – Cooling curves superimposed on I.T diagram - Effect of alloying elements on Fe-Fe3C system - hardenability, Jominy-end-quench test, Case hardening – Carburizing - Types, Nitriding, Cyaniding, Carbonitriding, Flame and Induction hardening.

UNIT – IV	**FERROUS AND NON FERROUS METALS**	**(9 Periods)**

Plain carbon steels – alloy steels - stainless and tool steels – Cast iron - Gray, White, Malleable, Spheroidal graphite - alloy cast irons – Heat resistant steels and Die steels. Alloys of Copper, Aluminum, Nickel, Magnesium, Titanium, Lead, Tin, Composite material, Types - PMCs, MMCs, CMCs, CAMCs, Material specification and standards.

UNIT – V	**TESTING OF MATERIALS**	**(9 Periods)**

Grain size determination by Microscopic techniques, Mechanical tests - tension, compression, impact, hardness, Low and high cycle fatigue test, Creep tests. Non destructive testing basic principles and testing method for radiographic testing - Ultrasonic testing, Magnetic particle inspection and Liquid penetrant inspection test - Eddy current testing - Basics of X Ray diffraction test - Bragg‘s law.

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*William D. Callister, Jr. and David G. Rethwisch,* ***"Materials Science and Engineering: An Introduction"****, Wiley, 10th Edition, 2018.*
2	*O.P. Khanna,* ***"Material Science and Metallurgy"****, Dhanpat Rai Publications, 2nd Edition, 2014.*

REFERENCES:

1	*George E. Dieter, **"Mechanical metallurgy"**, McGraw-Hill, 3rd Edition, 2017.*
2	*Sydney H.Avner, **"Introduction to Physical Metallurgy"**, McGraw-Hill, 2nd Edition, 2017.*
3	*Kenneth G.Budinski and Michael K.Budinski, **"Engineering Materials: Properties and Selection"**, Pearson Education, 9thEdition, 2016.*
4	*Raghavan V., **"Materials Science and Engineering"**, Prentice Hall India Learning Private Ltd., 6th Edition, 2015.*
5	*U.C.Jindal, **"Engineering Materials and Metallurgy"**, Pearson Education, 1st Edition, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge in the crystal structure and deformation of pure metals and alloys.	K3
CO2	Understand the alloy phase diagrams basics and their strengthening mechanisms.	K4
CO3	Select suitable and heat treatment methods for various metals and alloys.	K4
CO4	Understand the ferrous and nonferrous materials and their application.	K2
CO5	Gain knowledge about materials testing methods.	K4

25WPM305	THERMAL ENGINEERING LABORATORY II	SEMESTER III

PREREQUISITES	L	T	P	C
NIL	0	0	3	1.5

Course Objectives	To provide exposure to the students on studying the performance of heat transfer equipment's

LIST OF EXPERIMENTS

1. Test on pin fin apparatus.
2. Test on counter flow heat-exchanger.
3. Determination of convection heat transfer coefficient.
4. Determination of thermal resistance and conductivity.
5. Determination of emissivity of non-black surfaces.
6. Determination of transient temperature distribution.
7. Performance test on cooling tower.
8. Determination of COP of a heat pump.
9. Determination of COP of a refrigeration system.
10. Determination of COP of an air-conditioning system.
11. Study of Boiler, Steam turbines and Steam Engines.

Contact periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Conduct of experiments on heat transfer.	K4
CO2	Estimate COP of refrigerator, heat pump and air-conditioning system.	K4
CO3	Illustrate the working of boiler, steam turbines and steam engines.	K4

25WPM401	DYNAMICS OF MACHINES	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the techniques of Force analysis, Flywheel, Governors, Gyroscope, Balancing and vibration to solve engineering problems.

UNIT – I	FORCE ANALYSIS	(9 Periods)

Static equilibrium of two/three force members - Static equilibrium of member with two forces and torque – Static force analysis of linkages - D'Alembert's principle – Equivalent offset - Inertia force – Piston and crank effort – Turning moment on crankshaft – Turning moment diagrams – single cylinder double acting steam - Four stroke IC engine and multi-cylinder steam engine – Fluctuation of energy – Flywheel.

UNIT – II	GOVERNORS AND GYROSCOPE	(9 Periods)

Governors Terminology - Centrifugal governors -Watt governor - Dead weight governors - Porter - Proell governor - Spring controlled governor- Hartnell governor - Sensitivity, Stability – Hunting – Isochronism - Effort and Power of governor - Gyroscopic Motion Principles - Gyroscopic torque - Effect of gyroscopic couple.

UNIT – III	BALANCING OF MACHINES	(9 Periods)

Static and dynamic balancing - Balancing of several masses rotating in the same plane and different planes - Balancing of primary and secondary forces in reciprocating engine - Partial balancing of two - cylinder locomotives - Variation of tractive force - swaying couple - hammer blow.

UNIT – IV	FREE VIBRATION	(9 Periods)

Basic elements of vibrating system - Types of free vibrations - Longitudinal vibrations - Equilibrium method - Energy method - Rayleigh's method - Natural frequency of single degree freedom systems - Effect of spring mass - Damped free vibrations - Under damped - over damped and critically damped systems - Logarithmic decrement.

UNIT – V	FORCED VIBRATION	(9 Periods)

Undamped forced vibration of spring mass system – Torsional vibration - Damped forced vibrations - Rotating unbalance - Reciprocating unbalance - Vibration isolation - Support motion (absolute and relative motion) - Transverse vibration of shaft with single concentrated load, several loads, and uniformly distributed load - Critical speed. Introduction to Noise, Vibration and Harshness (NVH).

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*Sadhu Singh,* ***"Dynamics of Machines"****, Pearson Education India, Reprint Edition, 2023.*
2	*S. S. Rattan,* ***"Theory of Machines"****, McGraw Hill Education, 5th Edition, 2019.*

REFERENCES:

1	*Dhanesh N.Manik,* ***"Fundamentals of Mechanisms and Machines"****, Springer Nature, 1st Edition, 2024.*
2	*Alireza Abbasimoshaei & Thorsten A. Kern,* ***"Machine Dynamics: Kinematics and Dynamics",*** *Springer Nature, 1st Edition, 2023.*
3	*Sanjay K.Ghosal, Arun K. Samantaray & Sandipan Bandyopadhyay,* ***"Recent Advances in Industrial Machines & Mechanisms",*** *Springer Nature, 1st Edition, 2024*

4	*R. S. Khurmi and J. K. Gupta,* ***"Theory of Machines"****, S.Chand & Company, 14th Edition, 2020.*
5	*R. L. Norton,* ***"Kinematics and Dynamics of Machinery"****, McGraw Hill Education, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Able to solve force analysis and turning moment problems.	K1
CO2	Frame and solve Governor and Gyroscopic problems.	K2
CO3	Follow systematic procedure to do balancing of rotary and reciprocating masses.	K2
CO4	Derive equations for vibration problems and to solve free vibration problems.	K3
CO5	Derive equations for vibration problems and to solve forced vibration problems.	K3

25WPM402	METROLOGY AND MEASUREMENTS	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the concept of linear, angular and measuring instruments and the working principles of advanced devices used in metrology.

UNIT – I	LINEAR AND ANGULAR MEASUREMENTS	(9 Periods)

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.

UNIT – II	MAGNIFICATION AND FORM MEASUREMENT	(9 Periods)

Mechanical, Optical, electrical, Pneumatic method of magnification. Gear tooth terminology- Methods of measurements of run out, pitch, profile, lead, backlash, tooth thickness 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, composite method of inspection - Parkinson gear tester - Measurement of surface finish - Stylus probe instruments - Tomlinson and Talysurf Instrument- Straightness, Flatness and
Roundness measurement.

UNIT – III	TOLERANCE ANALYSIS	(9 Periods)

Sources of Variation, Tolerancing – Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Design of Limit gauges. Tolerance analysis in manufacturing, Process capability, tolerance stackup analysis – Worst case analysis and root sum of squares analysis, tolerance charting.

UNIT – IV	METROLOGY OF SURFACES	(9 Periods)

Fundamentals of GD & T - Conventional vs Geometric tolerance, Interpretation of GD&T Symbols in engineering drawings, Datums, Inspection of geometric parameters like straightness, flatness, roundness, perpendicularity, parallelism, symmetry, runout. Material conditions - concept of bonus tolerance, Simple problems. Measurement of Surface finish – Functionality of surfaces, Parameters, Surface roughness representation in engineering drawings, Comparative, Stylus based and Optical Measurement techniques, Filters – Selection of cut-off length, Introduction to 3D surface metrology- Parameters.

UNIT – V	ADVANCRES IN METROLOGY	(9 Periods)

Precision instruments based on Laser- laser interferometer – Universal Measuring Machine- Toolmaker's microscope - Coordinate Measuring Machine (CMM): need, construction, types, Applications- Computer Aided Inspection, Machine Vision - Basic concepts of Machine Vision System – Elements - Introduction to Nano metrology – Computer controlled systems used in inspection - Role of Metrology in Industry 4.0 / Smart Manufacturing.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*R. K. Jain, **"Engineering Metrology"**, Khanna Publishers, 2022.*

2	*Thomas G. Beckwith, Roy D. Marangoni and John H. Lienhard,* ***"Mechanical Measurements"****, Pearson Education, 2020.*

REFERENCES:

1	*S. C. Gupta,* ***"Engineering Metrology"****, Dhanpat Rai Publications, 2018.*
2	*Raghavendra and Krishnamurthy,* ***"Engineering Metrology and Measurements"****, Oxford Higher Education, 2013.*
3	*Dotson Connie,* ***"Fundamentals of Dimensional Metrology"****, Cengage Learning, Sixth edition, 2016.*
4	*Venkateshan, S. P.* ***"Mechanical Measurements"****, Second edition, John Wiley & Sons, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the Knowledge to operate linear and angular measurement devices.	K3
CO2	Gain knowledge about the Magnification, comparators, and form measurements with effective communication.	K2
CO3	To analyse the effect of tolerance in manufacturing, interpret the various tolerance symbols given in engineering drawings to choose the appropriate manufacturing process.	K4
CO4	To describe the principles and methods of form and surface metrology.	K4
CO5	To describe the advances in measurements for quality control in manufacturing Industries	K4

25WPM403	REFRIGERATION AND AIR CONDITIONING *(Use of Approved Refrigeration and Air conditioning Tables and Charts are Permitted)*	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To analyze various refrigeration system and to design the air conditioning system based on the heating and cooling load.	
UNIT – I	**REFRIGERATION CYCLES**	**(9 Periods)**
Air refrigeration cycles – Reversed Carnot Cycle, Bell Coleman cycle, Simple Vapour Compression Refrigeration Cycle, Compound Compression Refrigeration Cycles, and Cascade Refrigeration Cycles.		
UNIT – II	**VAPOUR ABSORPTION SYSTEM AND REFRIGERANTS**	**(9 Periods)**
Ammonia – Water System, Lithium Bromide – Water System - Electrolux Refrigeration System, Steam Jet Refrigeration and Solar Refrigeration Systems. Refrigerants – Properties and Classification– Eco-Friendly Refrigerants.		
UNIT – III	**SYSTEM COMPONENTS**	**(9 Periods)**
Compressors – Reciprocating, Rotary and Centrifugal Compressors, Evaporators- Flooded, Dry Expansion, Shell and Tube and Double Pipe Evaporators, Condensers – Air cooled, Water cooled and Evaporative Condensers, Expansion Devices – Automatic, Capillary tube and Thermostatic Expansion Valve.		
UNIT – IV	**DUCT DESIGN AND DISTRIBUTION**	**(9 Periods)**
Air distribution systems – study of different types of duct systems, methods of duct design, duct insulation, air purity – air cleaning methods.		
UNIT – V	**AIR CONDITIONING AND COOLING LOAD**	**(9 Periods)**
Psychrometry, Psychrometer, Psychometric processes, Moist Air behaviour, Effective Temperatures, Sensible Heat Factor ratio and Cooling Load Estimation for an Air-Conditioned Space.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*S. C. Arora and Domkundwar S., **"Refrigeration and Airconditioning"**, DhanpatRai & Sons 8th Edition, 2021.*
2	*P. N. Ananthanarayanan, **"Basic Refrigeration and Air Conditioning"**, McGraw Hill Education, 4th Edition, 2013.*

REFERENCES:

1	*Stocker, **"Refrigeration and Air Conditioning"**, McGraw Hill Education, 2014.*
2	*Manohar Prasad, **"Refrigeration and Air Conditioning"**, Wiley Eastern Limited, 2004.*
3	*R. K. Rajput, **"Refrigeration and Air Conditioning"**, S.K. Kataria & Sons, 2013.*
4	*C. P. Arora, **"Refrigeration and Air Conditioning"**, McGraw Hill Education, 3rd Edition, 2009.*
5	*P. N. Ananthanarayanan, **"Basic Refrigeration and Air Conditioning"**, McGraw Hill Education, 4th Edition, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve the problems on refrigeration cycle.	K2
CO2	Analyze the vapor absorption refrigeration system.	K3
CO3	Define the refrigeration system components.	K2
CO4	Design the duct geometry.	K4
CO5	Do the cooling load estimation.	K4

25WPM404	AUTOMATION LABORATORY	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	0	0	3	1.5

Course Objectives	To understand and practice the real time industrial applications of automation experiments related to Industry 4.0.

LIST OF EXPERIMENTS

1. Design of simple pneumatic circuit for direction control.
2. Design of electro pneumatic circuit for direction control.
3. Design of meter-in and meter-out circuit using electro pneumatics.
4. Design of sequential circuit using electro pneumatics.
5. Design of cascading circuit using electro pneumatics.
6. Training on advanced 4 axis robotic arm for industrial operations.
7. Study on the components and working of IoT system.
8. Programming of LoRaWAN IoT trainer for different industrial operations.
9. Study on the components and working of machine vision system.
10. Colour sorting applications using machine vision system.

Contact periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basic concepts of process automation through practical experiments on pneumatic systems.	K3
CO2	Analyze and construct the automation circuits using electro pneumatics	K4
CO3	Construct the robotic systems for basic automation experiments.	K3
CO4	Understand the components and working of industrial IoT system.	K3
CO5	Operate the machine vision for industrial application	K3

25WPM501	DESIGN OF MACHINE ELEMENTS *(Use of Approved Design Data Book is permitted)*	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To study proper procedure and standards to design the different machine elements depending on their physical and mechanical properties along with the theories of failures.

UNIT – I	BASICS OF DESIGN	(9 Periods)

Basic concept of design, classification of design, design procedure – factors influencing machine design, Engineering parameters - Stress-strain diagrams - Mechanical properties of engineering materials – preferred numbers, fits and tolerances – Modes of failure – Stresses acting on machine elements - Stress due to bending and eccentric axial loading - Principal stresses - Theories of elastic failure - Selection and application of failure theories.

UNIT – II	FLUCTUATING STRESSES AND DESIGN OF SHAFT	(9 Periods)

Fluctuating Stresses - Stress concentration - Fatigue failure - Endurance limit-low and high cycle fatigue – Notch Sensitivity - Reversed stresses - Soderberg, Goodman and Gerber relations - Design of shaft under static loading – Problems under single plane and two plane load acting shafts- Design of shaft under fatigue loading - Case studies.

UNIT – III	DESIGN OF ENERGY STORING ELEMENTS	(9 Periods)

Design of helical spring -, Design of torsional spring - Design of leaf springs - Design of flywheels considering stresses in rims and arms for engines and punching machines. Case studies - springs and flywheel.

UNIT – IV	DESIGN OF TEMPORARY AND PERMANENT JOINTS	(9 Periods)

Introduction about temporary joints – Types of temporary joints- Design of bolted joints (sleeve and cotter joint, knuckle joint) - Design of joints with variable loading, adhesive joints – Types of permanent joints - Design of riveted joints - Design of welded joints in plates and pressure vessels - Design of eccentrically loaded riveted and welded joints. Case studies - joint applications.

UNIT – V	MISCELLANEOUS ELEMENTS	(9 Periods)

Design of rigid coupling - Design of flexible coupling – Design of connecting rods - Design of crank shafts – Design and selection of rolling and sliding contact bearing.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*V. B. Bhandari,* ***"Design of Machine Elements",*** *McGraw Hill Education, 5thEdition, 2020.*
2	*T. V. Sundarajamoorthy and N. Shanmugam,* ***"Machine Design",*** *Anuradha Agencies Publishers, 2017.*

REFERENCES:

1	*J. E. Shigley and C. R. Mischke,* ***"Mechanical Engineering Design",*** *McGraw Hill International, 10th Edition, 2014.*
2	*R. S. Khurmi and J. K. Gupta,* ***"A text book of Machine Design",*** *S. Chand & Co, 2020.*
3	*N. C. Pandya and C. S. Shah,* ***"Machine Design",*** *20th Edition, 2015.*
4	*Gitin M. Maitra and L. V. Prasad,* ***"Hand Book of Mechanical Design",*** *2nd Edition, 2004.*

5	*Robert L. Mott,* ***"Machine Elements in Mechanical Design"****, Pearson, 2020.*
6	***"Design Data"*** *– P.S.G. College of Technology, Coimbatore.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the different types of designs, stresses, material properties and their significance in machine elements design	K4
CO2	Design the shafts by considering failure theories for reliability	K5
CO3	Design the energy storing elements for various applications according to the prescribed standards	K5
CO4	Design the temporary and permanent joints for fabrication of different machine components and boilers as per the standards	K5
CO5	Design the connecting rod, crank shaft and selection of couplings and bearings for industrial applications	K3

25WPM502	LEAN MANUFACTURING	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To craft the students to acquire knowledge in lean manufacturing tools, understand the methodology in implementing lean system in manufacturing scenario.

UNIT- I	INTRODUCTION TO LEAN MANUFACTURING	(9 Periods)

Historical evolution of lean manufacturing - Objectives and key principles of lean manufacturing - Conventional manufacturing versus lean manufacturing - Necessity of lean manufacturing - Basic elements of lean manufacturing - Systems and lean thinking - Lean images and lean tools - Ford System - Toyota Production system.

UNIT- II	LEAN TOOLS AND METHODOLOGY	(9 Periods)

Primary tools – 5S Principles and implementation – Just-In-Time – Pull versus Push system - Takt time - One piece flow - Principles of JIT - Implementation of Kanban system - Cellular manufacturing - Types of Layout, Principles of Cell layout - Pillars of TPM - Implementation process of TPM - Overall Equipment Effectiveness - Computation of OEE.

UNIT- III	PROCESS MAPPING AND SET UP TIME REDUCTION	(9 Periods)

Need for process maps - Types and its construction - Value Stream Mapping (VSM)- VSM symbols - Steps in preparing VSM - Comparison of Current state map and Future state map - Simulation scenario case studies - Set up time reduction - Single minute exchange of dies (SMED) - TQM Principles and implementation.

UNIT- IV	INTEGRATED QUALITY	(9 Periods)

Common errors - Mistake proofing - Poke Yoke and Andon methods - Load leveling - Heijunka - Visual management – Jidoka implementation - Process capability study - Lean Six Sigma - Design of Experiments (DOE)

UNIT- V	LEAN INVOLVEMENT AND CULTURE	(9 Periods)

Necessity of involvement – Waste of Humanity - Activities supporting involvement - Kaizen Circle Activity - Key factors in Practical Kaizen Training - Lean Culture - Standardization - 'Five Why' analysis - Various case studies of implementation of lean manufacturing at industries.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*P. Dennis,* ***"Lean Production Simplified: A Plain Language Guide to the World's Most Powerful Production System"****, Productivity Press, 2009.*
2	*N. Gopalakrishnan,* ***"Simplified Lean Manufacture: Elements, Rules,Tools and Implementation"****, Prentice Hall of India Learning Private Limited, 2010.*

REFERENCES:

1	*Ronald G. Askin & Jeffrey B. Goldberg,* ***"Design and Analysis of Lean Production Systems"****, John Wiley & Sons, 2003.*
2	*Don Tapping, Tom Luyster and Tom Shuker,* ***"Value Stream Management: Eight Steps to Planning, Mapping and Sustaining Lean Improvements"****, Productivity Press, 2007.*
3	*J. Liker and D. Meier,* ***"The Toyota Way"****, Field book, McGraw-Hill, 2010.*

4	*S. R. Devadasan, V. Mohan Sivakumar, R. Murugesh and P. R. Shalij,* ***"Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities"****, Prentice Hall of India Learning Limited, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe about the origin and foundation of lean production	K2
CO2	Explain various lean tools and methodologies.	K2
CO3	Explain the methods and processes of Value Stream Mapping.	K2
CO4	Describe about quality in lean system using various techniques.	K3
CO5	Describe about lean involvement and culture.	K2

25WPM503	POWER PLANT ENGINEERING	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the economics of power generation and the working of power plant components.

UNIT – I	**HYDRO POWER PLANTS**	**(9 Periods)**

Selection of site - Essential elements and classification of hydro power plants - Typical layout and associated components - Selection of turbines - Pumped storage plants - Advantages and disadvantages of water power.

UNIT – II	**THERMAL AND GAS TURBINE POWER PLANTS**	**(9 Periods)**

Layout of modern coal-based power plant. Super Critical Boilers - FBC Boilers. Subsystems - Water and Steam, Fuel and ash, Air and Gas - Diesel and Gas Turbine power plants- Layout and Functioning.

UNIT – III	**NUCLEAR POWER PLANTS**	**(9 Periods)**

Layout and subsystems - Fuels and Nuclear reactions - Boiling Water Reactor, Pressurized Water Reactor, Fast Breeder Reactor, Gas Cooled and Liquid Metal Cooled Reactors – working and Comparison - India's nuclear power program.

UNIT – IV	**RENEWABLE ENERGY POWER PLANTS**	**(9 Periods)**

Solar power plants - Photovoltaic and Thermal - Wind power plants - Vertical and Horizontal axes Wind Turbines - Biomass power plants - Gasification and combustion - Tidal and Ocean Thermal Energy plants. Geothermal plants - Fuel cell and its types.

UNIT – V	**ECONOMICS OF POWER GENERATION**	**(9 Periods)**

Load and load duration curves. Electricity billing – costing of electrical energy – Tariff structures - Economics of power plant – Fixed and variable cost - Payback period - Net Present Value, Internal Rate of Return.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods

TEXT BOOKS:

1	*P. K. Nag,* ***"Power Plant Engineering"****, McGraw Hill, 4th Edition, 2017.*
2	*R. K. Rajput,* ***" A Textbook of Power Plant Engineering"****, Laxmi Publications, 6th Edition, 2019.*

REFERENCES:

1	*S. C. Arora and S. Domkundwar,* ***"A Course in Power Plant Engineering"****, Dhanpat Rai and sons, 2014.*
2	*Paul Breeze,* ***"Power Generation Technologies"****, Elsevier Ltd., 2014.*
3	*M. M. El-Wakil,* ***" Power Plant Technology"****, McGraw Hill, 1st Edition, 2017.*
4	*G. Black,* ***"Power Plant Engineering"****, CBS, 2005.*
5	*G. R. Nagpal,* ***"Power Plant Engineering"****, Khanna publishers, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design and operate the hydro-electric power plants.	K2
CO2	Analyze the working of conventional power plants such as thermal and gas Turbines.	K4
CO3	Understand the working of nuclear power plants and its functional components.	K2
CO4	Apply the different types of renewable energy systems and its functional components into real life.	K2
CO5	Estimate the cost of power generation, electricity billing and rate of return on power plant investments.	K5

25WPM504	OPERATIONS RESEARCH	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To enrich the students with the knowledge on different industrial problems involving limited resources and strengthen the ability to choose an appropriate solution technique for solving the problems.

UNIT – I	LINEAR MODELS	(9 Periods)

Development of Operations Research – Characteristics and phases of Operation Research – Types of models – Linear Programming Problem – Formulation – Graphical method – Simplex algorithm – Big M method – Two phase method – Duality formulation – Dual simplex method.

UNIT – II	TRANSPORTATION AND ASSIGNMENT MODELS	(9 Periods)

Transportation models – Initial solution by North West Corner method – Least Cost Method – Vogel's Approximation Method – Optimality test – MODI method – Assignment problems - Hungarian method – Unbalanced and maximization type assignment problems – Travelling salesman problem.

UNIT – III	NETWORK MODELS AND SEQUENCING PROBLEMS	(9 Periods)

Construction of project networks – Network optimization algorithms – Shortest route models – Minimal spanning tree models – Maximum flow models – CPM and PERT networks – Critical path scheduling – Sequencing problems – *n* jobs through *two* machines – *n* jobs through *m* machines – *Two* jobs through *m* machines.

UNIT – IV	INVENTORY MODELS AND QUEUE THEORY	(9 Periods)

Inventory – Economic order quantity models – Quantity discount models – Probabilistic models – Safety stock and reorder point calculation – Queuing systems and structures – Notations and parameters – Queuing models.

UNIT – V	DECISION AND REPLACEMENT MODELS	(9 Periods)

Decision models – Game theory – Two-person zero sum games – Graphical solution – Replacement models – Economic life – Replacement of items that deteriorate with time – Value of money change with time, not change with time – Optimum replacement policy - Individual and group replacement.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOK:

1	*H. A. Taha*, ***"Operation Research"***, *Pearson Education*, *10th Edition,* 2017.
2	*Hira and Gupta,* ***"Problems in Operations Research"***, *S.Chand and Co., 2021.*

REFERENCES:

1	*J. K. Sharma,* ***"Operations Research"***, *Macmillan, 6th Edition, 2017.*
2	*Philip and Ravindran,* ***"Operational Research"***, *John Wiley, 2nd Edition, 2007.*
3	*Wagner,* ***"Operations Research"***, *Prentice Hall of India, 2000.*
4	*F. S. Hillier, G. J. Lieberman, B. Nag and P. Basu,* ***"Operations Research"***, *McGraw Hill, 11th Edition, 2021.*
5	*G. Srinivasan,* ***"Operations Research: Principles and Applications"***, *Prentice Hall of India, 3rd Edition, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply linear programming models to domain specific situations and solve by appropriate solution techniques.	K3
CO2	Analyze the various methods under transportation model and apply the model for testing the closeness of their results to optimal results	K4
CO3	Apply the concepts of PERT and CPM networks and sequencing models for decision making and optimally managing projects	K3
CO4	Analyze and apply appropriate inventory and queue theory techniques in domain specific situations.	K4
CO5	Make strategic decisions using decision and replacement models.	K6

25WPM601	DESIGN OF TRANSMISSION SYSTEMS *(Use of Approved Design Data Book is permitted)*	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the techniques of finite element analysis to model and solve structural, thermal, dynamic problems in engineering.

UNIT – I	DESIGN OF POWER TRANSMISSION ELEMENTS	(9 Periods)

Selection of ropes, Flat belt – V belt – ribbed V belt – selection of chains and sprockets – Ratchet and pawl mechanism.

UNIT – II	SPUR AND HELICAL GEARS	(9 Periods)

Kinematics – force analysis in gears – stress analysis – dynamic effects – gear blank design - estimating gear size, module and face width - power rating calculations based on strength and wear considerations, crossed helical gear terminology - estimating the size of the pair of crossed-helical gears.

UNIT – III	BEVEL AND WORM GEAR	(9 Periods)

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

UNIT – IV	DESIGN OF GEAR BOX	(9 Periods)

Geometric progression - standard step ratio - ray diagram, kinematic layout - design of sliding mesh and constant mesh gear box - introduction to planetary gear box. Introduction to fluid couplings.

UNIT – V	CAMS, CLUTCHES AND BRAKES	(9 Periods)

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches-axial clutches-cone clutches- introduction to Hydraulic clutch and electromagnetic clutches. Band and block brakes-external shoe brakes-Internal expanding shoe brake.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*V. B. Bhandari,* ***"Design of Machine Elements"****, McGraw Hill Education, 2020.*
2	*Joseph Edward Shigley and Charles R. Mischke,* ***"Mechanical Engineering Design"****, McGraw Hill Education, 2014.*

REFERENCES:

1	*R. C. Juvinal,* ***"Fundamentals of Machine Components Design"****, John Wiely and Sons. 2016.*
2	*M. F. Spotts, Terry E. Shoup and L. E. Hornberge,* ***"Design of Machine Elements"****, Pearson Education, 8th Edition, 2013.*
3	*Robert L. Mott,* ***"Machine Elements in Mechanical Design"****, Pearson, 2020.*
4	***"Design Data Book"****, P.S.G. College of Technology, Coimbatore.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select appropriate flexible transmission elements for machinery and equipments.	K1
CO2	Perform engineering analysis and estimate the required size and type of spur and helical gears.	K2
CO3	Perform engineering analysis and estimate the required size and type of bevel and worm gears.	K2
CO4	Design and develop gear box for various machinery and equipments.	K3
CO5	Design Cams, friction clutches and brake components.	K3

25WPM602	FINITE ELEMENT ANALYSIS	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To learn the techniques of finite element analysis to model and solve structural, thermal, dynamic problems in engineering.	
UNIT – I	**RELEVANCE OF FEM**	**(9 Periods)**
Historical background - basic concept of FEM – discretization of 1D, 2D and 3D Domains, mesh refinement and their types - convergence requirements – error estimates – Super convergent patch recovery (SPR), Recovery by equilibrium of patches (REP) -Introduction to gradient and divergence theorems - boundary and initial value problems.		
UNIT – II	**CHARACTERISTIC MATRICES AND LOAD VECTORS**	**(9 Periods)**
One dimensional governing equation - structural and heat transfer problems - variational method - variation calculus – weighted residual methods – Galerkin method - Ritz method - generalized coordinate's approach - principle of minimization of potential energy.		
UNIT – III	**ONE DIMENSIONAL PROBLEMS**	**(9 Periods)**
Derivation of shape functions, Stiffness matrices and force vectors -Assembly of Matrices - shape function characteristics - problems in axial load members, trusses, and heat transfer through composite walls and fins –Buckling of columns.		
UNIT – IV	**TWO DIMENSIONAL PROBLEMS**	**(9 Periods)**
Derivation of shape functions for CST and LST triangular and rectangular elements, Stiffness matrices and force vectors - Pascal's triangle- concept of plane stress and plain strain and axi-symmetry - Structural and heat transfer application - introduction to coupled field analysis.		
UNIT – V	**HIGHER ORDER ELEMENTS**	**(9 Periods)**
Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Jacobian transformation - Serendipity and Lagrangian elements – Numerical integration - Matrix solution techniques.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Larry J. Segerlind,* ***"Applied Finite element Analysis"****, John Wiley & Sons, 2010.*
2	*Daryl L. Logan,* ***"A First Course in the Finite Element Method"****, Thomson Learning, 5th Edition, 2016.*

REFERENCES:

1	*Singiresu S. Rao,* ***"The Finite Element Method in Engineering"****, Butter Wort Heinemann, 5th Edition, 2017.*
2	*J. N. Reddy,* ***"An Introduction to Finite Element Method"****, McGraw Hill Education, 4th Edition, 2020.*
3	*Tirupathi R. Chandrupatla and Ashok D. Belegundu,* ***"Introduction to Finite Element in Engineering"****, Pearson Education, 4th Edition, 2021.*
4	*David V. Hutton,* ***"Fundamentals of finite element Analysis"****, McGraw Hill Education, 2011.*
5	*P. Seshu,* ***"Textbook of Finite Element Analysis"****, Prentice Hall of India, 2012.*

6	*Olek C. Zienkiewicz,* ***"The Finite Element Method: Its Basis and Fundamentals"****, Butterworth-Heinemann Ltd, 7th Edition, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select appropriate mathematical techniques for solving Finite Element problems.	K1
CO2	Frame and solve strong and weak form equations for structural and non-structural problems.	K2
CO3	Follow systematic procedure to solve one dimensional problem.	K2
CO4	Derive equations for complex 2D problems and to solve simple 2D problems.	K3
CO5	Formulate necessary matrices for 3D elements.	K3

25WPM603	INDUSTRY 4.0	SEMESTER VI

PREREQUISITES	L	T	P	C
Basic knowledge of computers, manufacturing processes and engineering mathematics.	3	0	0	3

Course Objectives	To provide knowledge on Industry 4.0 technologies such as Big Data, Artificial Intelligence, Augmented Reality and Internet of Things for developing smart industrial and manufacturing solutions.

UNIT–I	INTRODUCTION TO INDUSTRY 4.0	(9 Periods)

Digitalization and Networked Economy - Introduction to Industry 4.0 - Comparison of Conventional and Smart Factories – Internet of Things (IoT) and Industrial IoT (IIoT) - Smart Manufacturing - Smart Sensors and Smart Logistics - Cyber Physical Systems (CPS) - Machine to Machine (M2M) Communication – Cloud Computing - Industrial Big Data - Predictive Maintenance - Digital Twin - Architecture of Industry 4.0.

UNIT–II	BIG DATA AND DATA ANALYTICS	(9 Periods)

Data Evolution and Big Data Concepts - Characteristics and Components of Big Data - Data Acquisition in Manufacturing Industries - Data Analytics for Production Systems - Statistical Methods for Industrial Data - Predictive Analytics - Data Visualization - Python Basics for Industrial Data Analysis - Applications of Big Data in Quality Control, Supply Chain and Smart Manufacturing.

UNIT–III	ARTIFICIAL INTELLIGENCE	(9 Periods)

Artificial Intelligence - Foundations of AI - Application Domains and Tools - Associated Technologies of AI - Future Prospects and Challenges of AI - Basics of Machine Learning - Machine Learning Applications in Manufacturing - Natural Language Processing - Speech Processing - Reinforcement Learning - Bio-inspired Computing - Agent Based Computing - Evolutionary Computing - Deep Learning - AI Applications in Smart Industries and Industrial Automation.

UNIT–IV	AUGMENTED REALITY	(9 Periods)

Introduction to Augmented Reality (AR) and Virtual Reality (VR) - AR/VR Devices and Technologies - Human Machine Interaction - Virtual Prototyping - Product Design and Visualization - AR/VR in Manufacturing, Assembly and Maintenance - Simulation and Training Applications - Digital Twin Applications - Industrial Case Studies and Future Trends.

UNIT–V	INTERNET OF THINGS	(9 Periods)

Introduction to IoT - Sensors and Actuators for Industrial Applications - Arduino Platform and C Programming – Raspberry Pi and Python Programming – IoT Communication Networks and Protocols - Embedded Systems for Smart Manufacturing - Cloud IoT Platforms - Cybersecurity in Industrial IoT - Smart Factory Applications - Industrial Automation and Monitoring Systems.

Contact Periods:
Lecture:45 Periods **Tutorial: 0 Periods** **Practical:0 Periods** **Total:45 Periods**

TEXTBOOKS:

1	*Alasdair Gilchrist, **"Industry 4.0: The Industrial Internet of Things"**, A press, 2016*
2	*Alp Ustundag and EmreCevikcan, "**Industry 4.0: Managing The Digital Transformation**", Springer Series in Advanced Manufacturing., Switzerland, 2017.*

REFERENCES:

1	*P.Kaliraj, T. Devi, "**Artificial Intelligence Theory, models and Application"s**, 2022, ISBN 9781032008097, CRC Press, Taylor & Francis Group*
2	*Stuart J. Russell and Peter Norvig, **"Artificial Intelligence: A Modern Approach",** Pearson Education, 4th Edition, 2021.*
3	*Bernard Marr, **"Extended Reality in Practice"**, John Wiley & Sons, 1st Edition, 2021.*
4	*Ronald R. Yager and Jordan Pascual Espada, "**New Advances in the Internet of Things**", Springer., Switzerland, 2018.*
5	*Nathan Marz and James Warren,**"Big Data: Principles and Best Practices of Scalable Realtime Data Systems"**, Manning Publications, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the fundamentals and enabling technologies of Industry 4.0.	K2
CO2	Apply Big Data and Data Analytics concepts for industrial applications.	K3
CO3	Illustrate the principles and applications of Artificial Intelligence and Machine Learning in industries.	K2
CO4	Analyze the applications of Augmented Reality and Virtual Reality in smart manufacturing systems.	K4
CO5	Develop basic IoT based solutions for industrial automation and monitoring applications.	K3

25WPM604	INDUSTRIAL ROBOTICS	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To familiarize students with the concepts and techniques of robot manipulator, its kinematics, programming and build confidence to choose, evaluate and incorporate robots in engineering systems.	
UNIT – I	**FUNDAMENTALS OF ROBOT**	**(9 Periods)**
Robot; definition, robot anatomy, work envelope, types and classification, joint notations, types of joints, robot parts and their functions, specifications, speed of motion, pay load, precision of movement; Need for robots in Indian scenario, A view on Global and Indian manufacturers of Robots.		
UNIT – II	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	**(9 Periods)**
Drives; hydraulic, pneumatic, mechanical, electrical, Servo motors, Stepper motors, salient features, application, End effectors; types, Grippers; mechanical, pneumatic, hydraulic, magnetic, vacuum and limitations, Multiple grippers.		
UNIT – III	**SENSORS AND MACHINE VISION**	**(9 Periods)**
Requirements of sensors, principles, types and applications of: Proximity (Inductive, Hall effect, Capacitive, Ultrasonic and Optical) – Speed, Position (resolvers, optical encoders) – Force – Torque – Touch sensors, Introduction to Machine Vision; functions, image processing and analysis, training the vision system.		
UNIT – IV	**DIRECT AND INVERSE KINEMATICS**	**(9 Periods)**
Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints- Representation using the Denavit Hattenberg parameters - Degrees of freedom-Direct Kinematics - Inverse kinematics- SCARA robot.		
UNIT – V	**APPLICATIONS, IMPLEMENTATION AND ROBOT ECONOMICS**	**(9 Periods)**
Robot cell design; types, application of robots in processing, assembly, inspection, material handling in Automobile, Medical Nuclear Industries, Implementation of robots in industries; safety considerations for robot operations, safety codes, Economic analysis of robots; pay back and rate of return method.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS:

1	*Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, and Ashish Dutta,* ***Industrial Robotics: Technology, Programming and Applications"****, McGraw-Hill Education, 2nd Edition, 2017.*
2	*Ramachandran Nagarajan,* ***"Introduction to Industrial Robotics"****, Pearson Education, 1st Edition, 2016.*

REFERENCES:

1	*Ashitava Ghoshal,* ***"Robotics-Fundamental Concepts and Analysis"****, Oxford University Press, Sixth Edition, 2010.*
2	*R. K. Mittal and I. J. Nagrath,* ***"Robotics and Control"****, Tata McGraw Hill, 2017.*

3	*S. K. Saha,* ***"Introduction to Industrial Robotics"****, McGraw Hill Education, 2nd Edition, 2017.*
4	*Rex Miller and Mark R. Miller,* ***"Robots and Robotics: Principles, Systems, and Industrial Applications****", McGraw Hill Education, 1st Edition, 2017.*
5	*K. K. Appu Kuttan,* ***"Robotics"****, I K International Publishing House Pvt. Ltd, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select the robot for the various industrial applications.	K3
CO2	Control the robot actuation by selecting appropriate drives.	K3
CO3	Analyse the role of the sensors, machine vision and manipulators in robotic System.	K3
CO4	Evaluate the robot kinematics of a robot.	K4
CO5	Employ the robots in industries and identify the social and economic challenges.	K3

25WPM701	TOTAL QUALITY MANAGEMENT	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To facilitate the understanding of total quality management principle, processes and to develop a product with the required quality at affordable price with the satisfaction of customer.

UNIT – I	QUALITY CONCEPTS	(9 Periods)

Introduction, need for quality, evolution of quality, definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality, case studies.

UNIT – II	TQM PRINCIPLES	(9 Periods)

TQM principles; leadership, strategic quality planning; Quality councils, employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCA cycle, 5S, Kaizen, e-Kanban; Supplier partnership, Partnering, Supplier rating & selection, Quality Awards.

UNIT – III	STATISTICAL PROCESS CONTROL	(9 Periods)

The seven traditional tools of quality; New management tools; Statistical fundamentals, population and sample, normal curve, control charts for variables, attributes and its applications, process capability; Six sigma, concepts, methodology, certification, applications to manufacturing, service sector including IT.

UNIT IV	TOOLS AND TECHNIQUES	(9 Periods)

Benchmarking needs and benefits, benchmarking process, Quality function deployment (QFD); house of quality, Taguchi quality loss function, Total productive maintenance (TPM); pillars of TPM, Failure Mode Effective Analysis (FMEA); Failure rate, types of FMEA, stages of FMEA, Case studies.

UNIT V	QUALITY SYSTEMS	(9 Periods)

Introduction to ISO 9000 and other quality system; ISO 9001:2015 quality system, elements, implementation of quality system, documentation, quality auditing, QS 9000, ISO 14000; concept, requirements and benefits, integrating ISO 14000 with ISO 9000, ISO45000, IATF16949; Implementation of TQM in manufacturing industry.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary and Urdhwareshe Hemant,* ***"Total Quality Management"****, Pearson Education, 5th Edition, 2018.*
2	*Subburaj Ramasamy,* ***"Total Quality Management"****, McGraw Hill Education, 2017.*

REFERENCES:

1	*James R. Evans and William M. Lindsay,* ***"The Management and Control of Quality"****, South-Western, 2010.*

2	*Poornima M. Charantimath,* ***"Total Quality Management"****, Pearson Education, 4th Edition, 2022.*
3	*P. N. Mukherjee,* ***"Total Quality Management"****, PHI Publishers, 2006.*
4	*B. Janakiraman and R. K. Gopal,* ***"Total Quality Management"****, Prentice Hall India, 1st Edition, 2006.*
5	*Tapan K. Bose,* ***"Total Quality Management"****, Pearson Education, 2010.*
6	*John L. Hradesky,* ***"Total Quality Management Hand book"****, McGraw-Hill, 1995.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the principle of strategic planning, Deming philosophy and leadership concepts in industries.	K2
CO2	Apply the principle of TQM in industries.	K3
CO3	Evaluate statistical process control in industries.	K3
CO4	Select appropriate quality tools to meet industrial requirements.	K3
CO5	Implement appropriate quality standards for industries.	K3

25WPM702	PROJECT WORK	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	0	0	16	8

Course Objectives	To provide opportunities for students to collaborate in small teams and apply the knowledge gained throughout the program to identify, formulate, analyze, and solve research, societal, environmental, and industrial problems, thereby enhancing teamwork, problem-solving ability, innovation, communication skills, and lifelong learning.

The students may be grouped into groups of maximum of four members per group and work under a project supervisor. The device / system / component(s) to be fabricated / investigated / analyzed may be decided in consultation with the supervisor. An industrial expert may be included as an external supervisor. A project report to be submitted by the group and the fabricated model / investigation / analysis to be reviewed and evaluated continuously by a committee constituted by the head of the department.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 240 Periods Total: 240 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Model or simulate solutions to small engineering problems by considering environmental and sustainability aspects.	K6
CO2	Apply the principles of mechanical engineering to analyze and solve industrial engineering problems.	K3
CO3	Perform feasibility studies and manage project activities to complete assigned tasks within the specified time frame.	K5
CO4	Demonstrate the ability to assign, undertake, and complete responsibilities effectively as an individual and as a member of a multidisciplinary team.	K3
CO5	Prepare and deliver technical reports and presentations to communicate project outcomes effectively to technical and non-technical audiences.	K3

25WPM4E1	ADDITIVE MANUFACTURING TECHNIQUES	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To educate the students with fundamental and advanced knowledge in the field of additive manufacturing technology and associated aerospace, architecture, art, medical and industrial applications.

UNIT- I	INTRODUCTION	(9 Periods)

General Overview - Introduction to Reverse Engineering - Traditional manufacturing vs Additive Manufacturing (AM) - Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) - Different AM processes and relevant process physics - AM process chain Application level: Direct processes - Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping - Indirect Tooling, Indirect Manufacturing.

UNIT- II	MATERIALS SCIENCE FOR AM	(9 Periods)

Choosing materials for Manufacturing - Multiple Materials - Metal AM Processes and Materials - Composite Materials - Biomaterials, Hierarchical Materials & Biomimetics - Ceramics & Bio- ceramics - Shape-Memory Materials, 4D Printing & Bio-active materials Role of solidification rate Evolution of non-equilibrium structure, Structure property relationship Grain structure and microstructure.

UNIT- III	SOFTWARE AND METHODS	(9 Periods)

Designing for Additive Manufacturing (DfAM) - Software Tools vs. Requirements – Pre & Post- processing - 3D Scanning & the Scanning Process - Sculpting & Repairing data AM File Formats - STEP file format-More detail on NURBS - Model Validation.

UNIT- IV	POWDER BASED ADDITIVE MANUFACTURING SYSTEMS	(9 Periods)

Transport phenomena models: temperature, fluid flow AM and composition, buoyancy driven tension driven free surface flow pool. Case studies: Numerical modeling of AM process, Powder bed melting based process, Droplet based printing process Residual stress, part fabrication time, cost, optimal orientation and optimal Defect in AM and role of transport Simulations (choice of parameter, Mo de! validation for different.

UNIT- V	APPLICATIONS AND THE BUSINESS OF AM	(9 Periods)

Choosing the Right Manufacturing Process, Injection Molding, Casting, Mold-making. Direct Digital Manufacturing, Distributed Manufacturing, Mass Customization, Biomedical Applications, Aerospace & Automotive Applications Architectural Engineering Food & Consumer Applications Personalized surgery Art, Fashion, Jewellery, Toys & Other Applications Intellectual Property Trade-offs of Open-Source vs Proprietary Systems, Gartner hype cycle viz 3D Printing. Total cost of ownership Business Considerations for Material Selection Commercialization Trends, Business
Opportunities & Future Directions.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Chua Chee Kai and Leong Kah Fai,* ***"Rapid Prototyping: Principles and Applications in Manufacturing"****, World Scientific Publishing Co. Pte Ltd, 2000.*

2	*Paul F. Jacobs,* ***"Stereo-lithography and other RP & M Technologies: from Rapid Prototyping to Rapid Tooling"****, ASME Press, 1996.*

REFERENCES:

1	*Ian Gibson, David Rosen, Brent Stucker and Mahyar Khorasani* ***"Additive manufacturing technologies"****, Springer, 3rd Edition, 2021.*
2	*C. K. Chua, K. F. Leong and C. S. Lim,* ***"Rapid prototyping: Principles and applications"****, World Scientific Publishers, 2nd Edition, 2010.*
3	*A. Gebhardt,* ***"Rapid prototyping"****, Hanser Gardener Publications, 2003.*
4	*L. W. Liou and F. W. Liou,* ***"Rapid Prototyping and Engineering applications: A tool box for prototype development"****, CRC Press, 2011.*
5	*P. D. Hilton and P. F. Jacobs,* ***"Rapid Prototyping and Engineering applications: A tool box for prototype development"****, CRC press, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the need and fundamentals of additive manufacturing (AM) systems.	K3
CO2	Create and analyse 2D and 3D models using CAD modelling software, discuss the fundamentals of reverse engineering and integrating with manufacturing systems.	K3
CO3	Describe various AM Technologies	K3
CO4	Apply knowledge of powder based additive manufacturing techniques in the field of manufacturing and other fields.	K3
CO5	To gain knowledge on application and the business of AM.	K3

25WPM4E2	MECHATRONICS	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To study the mechatronics system and understand the concepts of integration and design of mechatronics systems.

UNIT – I	**INTRODUCTION TO MECHTRONICS**	**(9 Periods)**

Introduction – Definition - Mechatronic approach, Integrated product design - Application areas. Open and closed loop control system - Embedded systems - Components overview- Actuators - Hydraulic and pneumatic actuators - E lectrical Actuators - Servo motor and stepper motor - Mechanical actuation systems - Selection of actuators.

UNIT – II	**SENSORS AND SIGNAL CONDITIONING**	**(9 Periods)**

Sensors - Types - Position - Proximity - Force - Velocity - Pressure - Temperature - Fluid flow -Optical - Image sensors - Working principle - Specification - Application - Selection of sensors - Signal conditioning - Types of operational amplifiers - Protection and filtering- Wheatstone bridge - Analogue-to-digital and Digital-to-analogue converters.

UNIT – III	**SYSTEM MODELLING AND CONTROL SYSTEMS**	**(9 Periods)**

Mathematical models - Building blocks of mechanical, electrical, fluid and thermal system- Rotational translational systems, Electro mechanical systems - Linearity - Hydraulic mechanical systems. Continuous and discrete control process - Two step mode, PI, PD, PID controllers, micro controllers-digital controllers, PLC programming.

UNIT – IV	**MEMS and SMART MATERIALS**	**(9 Periods)**

MEMS-Introduction-economy of MEMS manufacturing - MEMS design-micro sensors, micro actuators - micro-fabrication techniques – LIGA Process- lithography, etching, micro-joining. Introduction to smart materials - Shape Memory Alloy- properties- working principle of piezoelectric and magneto strictive actuators.

UNIT – V	**APPLICATIONS AND CASE STUDIES**	**(9 Periods)**

Mechatronic systems from robotics manufacturing - Consumer mechatronics products - Surgical equipment - Introduction to artificial intelligence. Case studies - Automated glue dispensing system - mechatronic design of a coin counter - mechatronic design of a robotic walking machine- automated mining shovel-automated air conditioner.

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*W. Bolton,* ***"Mechatronics"****, Longman, 2nd Edition, 2023.*
2	*Michael B. Histand and David G. Alciatore,* ***"Introduction to Mechatronics and Measurement Systems"****, Tata McGraw Hill, 2nd Edition, 2006.*

REFERENCES:

1	*D. A. Bradley, D. Dawson, N. C. Buru and A. J. Loader,* ***"Mechatronics"****, Chapman and Hall,1993.*
2	*Dan S. Necsulescu,* ***"Mechatronics"****, Pearson Education, 2016.*
3	*Devdas Shetty and Richard A. Kolk,* ***"Mechatronics System Design"****, PWS Publications, 2007.*
4	*A. Smaili and F. Mrad,* ***"Mechatronics: Integrated Technologies for Intelligent Machines"****, Oxford University Press, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the key elements of mechatronics system and models	K1
CO2	Select appropriate sensors and transducers for industrial application.	K2
CO3	Integrate mechanical, electrical, electronics, control systems in the mechatronics system design	K3
CO4	Select the proper smart material for the mechatronics system.	K3
CO5	Apply the principles of mechatronics in industrial needs	K4

25WPM4E3	AUTOMOBILE ENGINEERING	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To classify the engine components and accessories, understand the concepts of steering, brakes and suspension systems and discuss the alternative energy sources, hybrid and off-road vehicles.

UNIT – I	**VEHICLE STRUCTURE AND ENGINES**	**(9 Periods)**

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics - Components of Engine – Functions and Materials - Cooling and Lubrication systems in Engine – Turbo Chargers – Engine Emission Control by 3-Way Catalytic Controller - Electronic Engine Management System.

UNIT – II	**ENGINE AUXILIARY SYSTEMS**	**(9 Periods)**

Electronic control of carburetion - Electronic fuel injection system – Mono-point and Multi - Point Injection Systems – Construction, Operation and Maintenance of Lead Acid Battery – Electrical systems – Battery generator –Advanced starting system technology – Lighting and Ignition systems – Regulators - Cut outs.

UNIT – III	**TRANSMISSION SYSTEMS**	**(9 Periods)**

Clutch – Types and Construction – Gear Boxes, Manual and Automatic – Gear shift mechanisms – 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.

UNIT – IV	**STEERING, BRAKES AND SUSPENSION SYSTEMS**	**(9 Periods)**

Steering Geometry and Types of steering gear box– Power Steering - Types of Front Axle – Suspension systems – Braking Systems – Types and Construction – Antilock Braking System – Electronic brake force distribution (EBD) and traction control - Wheels and Tyres - Wheel Alignment Parameters.

UNIT – V	**ALTERNATIVE ENERGY SOURCES**	**(9 Periods)**

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Alcohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel Cells – Introduction to off road vehicles.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Kirpal Singh, **"Automobile Engineering Vol. 1 & 2"**, Standard Publishers Distributors, 2020.*
2	*R. B. Gupta, **"Automobile Engineering"**, Satya Prakashan, 2024.*

REFERENCES:

1	*William Crouse and Donald Anglin, **"Automotive Mechanics"**, McGraw Hill Education, 10th Edition, 2017.*
2	*K. K. Ramalingam, **"Automobile Engineering – theory and Practice"**, Scitech Publications, 2011.*
3	*S. K. Gupta, **"A Textbook of Automobile Engineering"**, S. Chand Publishing, 2nd Edition, 2020*

4	*K. K. Jain and R. B. Asthana,* ***"Automobile Engineering"****, McGraw Hill Education, 1st Edition, 2017.*
5	*C. P. Nakra,* ***"Basic Automobile Engineering"****, Dhanpat Rai Publishing Company, 2023.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the engine components and accessories.	K2
CO2	Explain fuel supply and electrical systems.	K3
CO3	Explain the working principle of various transmission and control systems.	K3
CO4	Understand the concepts of steering, brakes and suspension systems	K2
CO5	Discuss the alternative energy sources, hybrid and off-road vehicles.	K4

25WPM4E4	COMPOSITE MATERIALS	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart the fundamentals of composite materials with different reinforcement, matrix materials and comprehend the types of manufacturing methods for advanced composite materials to meet various engineering requirements.

UNIT – I	**BASICS OF COMPOSITE MATERIALS**	**(9 Periods)**

Classification and characteristics of composite materials - Mechanical behavior – Polymer matrix composites – Metal matrix composites – Ceramic matrix composites - Basic terminology and Manufacture of laminated fiber - Reinforced composite materials - Current and potential advantages – Structural and Multifunctional - Applications of composite materials.

UNIT – II	**REINFORCEMENT AND MATRICES**	**(9 Periods)**

Different types of fibers and resins – Glass – Boron – carbon – organic – ceramic – whiskers and other Nonoxide Reinforcements - Properties and applications of fibers - Roll of matrix - Matrix materials, Selection of matrix -Thermoset matrix -Thermoplastic matrix, Fiber architecture – Natural Fibers.

UNIT – III	**DESIGN OF COMPOSITE STRUCTURES**	**(9 Periods)**

Elements of Design - Steps in design process – Static, dynamic and stability analysis – Laminated composites plates - inter laminar stresses – stress distribution in fiber and the matrix - Design analysis stages - Material selection - Configuration selection - Laminate joints - Design requirements and design failure criteria.

UNIT – IV	**MANUFACTURING OF COMPOSITES**	**(9 Periods)**

Fundamentals terms – requirement and selection of constituents - Bagging films - Molding process - Compression molding - Pultrusion – pre-peg layer - Filament winding - Liquid composite molding processes - Resin film infusion - Elastic reservoir molding -Tube rolling - Forming methods for thermoplastic matrix composites.

UNIT – V	**METAL, CERAMIC AND CARBON MATRIX COMPOSITES**	**(9 Periods)**

Metal matrix composites (MMC) - Characteristics of MMC – Types – reinforcement effects – volume fraction – rule of mixtures – processing of MMC - Ceramic matrix composites (CMC) – types and properties – sintering – cold and hot isostatic pressing - processing of CMC - Carbon matrix composites – Characteristics and constituents - Fabrication methods - Applications.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Krishnan K. Chawla,* ***"Composite Materials: Science and Engineering"****, Springer India, 3rd Edition, 2015.*
2	*P. K. Mallick,* ***"Fiber-Reinforced Composite materials: Manufacturing and Design"****, CRC Press, 3rd Edition, 2019.*

REFERENCES:

1	*A. K. Bhargava,* ***"Engineering Materials: Polymers, Ceramics and Composites"****, Prentice Hall India Learning Private Limited, 2004.*
2	*Michael W. Hyer,* ***"Stress Analysis of Fiber-Reinforced Composite Materials"****, Destech Pubns Inc, 2008.*
3	*Madhujit Mukhopadhyay,* ***"Mechanics of Composite Materials and Structures"****, Universities Press, 2022.*
4	*Robert M. Jones,* ***"Mechanics of Composite Materials"****, CRC Press, 2nd Edition, 2018.*
5	*Ronald F. Gibson,* ***"Principles of Composites Materials Mechanics"****, CRC Press, 4th Edition, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the mechanics and behavior of reinforced composite materials for specific applications and developing composite materials for sustainability.	K2
CO2	Formulate different types of reinforcement and matrices to develop new composite material for the various applications.	K3
CO3	Design and manufacture post processing methods of composite structures and capable to perform various analysis	K3
CO4	Execute different methods of manufacturing advanced composites to meet the innovative demand in engineering.	K2
CO5	Fabricate metal matrix, ceramic matrix and carbon matrix composite for various engineering applications to meet societal demand.	K4

25WPM4E5	INDUSTRIAL ENGINEERING	SEMESTER IV

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To enable the students to apply engineering principles and quality tools in the work environment and work collaboratively.

UNIT – I	FORECASTING METHODS	(9 Periods)

Characteristics and Principles of forecasting – Qualitative methods – Delphi technique, Market Research – Time-series analysis – Moving averages – Exponential smoothing method – Regression models – Measurement of forecast errors – Break Even analysis – Elements of Cost – Tutorial problems.

UNIT – II	FACILITIES PLANNING AND WORK STUDY	(9 Periods)

An overview of facilities planning – Engineering economic analysis – Facilities location problems – Types of layouts – Computerized layout planning – Group Technology – Objectives of Work Study – Method Study – Time Study – Work Measurement Techniques – Principles of Motion Economy – Motion Study – Predetermined Motion Time System (PMTS) – Work Sampling Techniques – Ergonomics.

UNIT – III	AGGREGATE PLANNING	(9 Periods)

Objectives of aggregate planning – Development of master production schedule – Capacity planning – Materials requirements planning (MRP-I) – Designing and managing the MRP System – Manufacturing resources planning (MRP-II) – Enterprises resources planning (ERP).

UNIT – IV	SCHEDULING OF OPERATIONS	(9 Periods)

Operations planning and scheduling – Scheduling techniques – Stages in scheduling – Loading, dispatching, expediting – Machine loading charts – Priority sequencing – Dynamic Sequencing Rules – Batch scheduling – Economic batch quantity – Scheduling in Repetitive, batch and job shop production – Resource balancing – Flexible manufacturing system.

UNIT – V	PROJECT MANAGEMENT	(9 Periods)

Categories of projects – Project life cycle phase – Roles and responsibilities of project leader – Project management – Scope – Tools and techniques – Work Breakdown Structure – Validation and control – Project risk management – Identification of risks - Qualitative and quantitative risk analysis – Control risks – Preparation of cost estimation.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*R. Panneerselvam*, ***"Production and Operations Management"***, *Prentice Hall of India, 3rd Edition, 2012.*
2	*O. P. Khanna*, **"*Industrial Engineering and Management*"**, *Dhanpat Rai Publications, 17th Edition, 2018.*

REFERENCES:

1	*T. E. Vollman*, ***"Manufacturing Planning and Control systems"***, *Galgotia Publications, 2004.*

2	*Elwood S. Buffa and Rakesh K. Sarin*, ***"Modern Production and Operations Management"***, *John Wiley and Sons, 8th Edition, 2007.*
3	*Prasana Chandra,* ***"Project Planning Analysis selection financing Implementation and Review"****, Tata Mc Graw Hill Publication, 7th Edition, 2023.*
4	*C. Nadha Muni Reddy*, ***"Industrial Engineering and Management"***, *New Age International (P) Ltd., 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply forecasting tools to analyze the demand pattern and forecast the demand.	K3
CO2	Familiarize the various facilities' layouts and work study techniques.	K2
CO3	Understand the aggregate production planning.	K2
CO4	Develop the best scheduling of operations in the workplace.	K6
CO5	Analyze the risks involved in projects and control the risks.	K4

25WPM5E1	PROCESS PLANNING AND COST ESTIMATION	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To introduce the process planning concepts, cost estimation for various manufacturing process.

UNIT- I	INTRODUCTION TO PROCESS PLANNING	(9 Periods)

Aims and Objectives, Place of process planning in Manufacturing cycle - Process and Production Planning. Drawing interpretation, Dimensional tolerance - Production processes.

UNIT- II	PROCESS PLANNING STEPS	(9 Periods)

Design of a process plan – Selection of production processes, tools and process parameters - Positioning and work holding devices, Selection of inspection devices and tools, Documenting the process plan. Computer-Aided Process Planning (CAPP) – Benefits, Architecture and approaches.

UNIT- III	INTRODUCTION TO COST ESTIMATION	(9 Periods)

Cost estimation - Importance -Types and Purpose - Components - Procedure - Classification of costs - Cost elements - Cost ladder - Overhead expenses - Break-even analysis - Concept, make or buy decision - Assumptions, merits and demerits - Applications - Linear, multi product break-even analysis.

UNIT- IV	PRODUCT LIFE CYCLE MANGEMENT AND PRODUCTION COST ESTIMATION	(9 Periods)

Product life cycle management - Estimation of production cost for Cast components, Welded components, Forged components, Powder metallurgy parts.

UNIT- V	ESTIMATION OF MACHINING TIME AND COST	(9 Periods)

Estimation of Machining time – Lathe operations, Drilling, Milling, Shaping, Planing and Grinding, Cost estimation for machining processes.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*R. Panneerselvam and P. Sivasankaran,* ***"Process Planning and Cost Estimation"****, PHI Learning (P) Ltd., 2015.*
2	*M. Adithan,* ***"Process Planning and Cost Estimation"****, New Age International (P) Ltd., 2015.*

REFERENCES:

1	*Thomas E. Vollmann,* ***"Manufacturing Planning and Control Systems"****, Galgotia Publications Pvt. Ltd., 1998.*
2	*Samuel Eilon,* ***"Elements of Production Planning and Control"****, MacMillan, 1985.*
3	*R. Kesavan, C. Elanchezhian and B. Vijayaramanath,* ***"Process Planning and Cost Estimation"****, New Age International (P) Ltd., 2019.*
4	*B. S. Narang and V. Kumar,* ***"Production and Costing"****, Khanna Publishers, 2014.*
5	*T. R. Banga and S. C. Sharma,* ***"Mechanical Estimating and Costing"****, Khanna Publishers, 2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the concept of process planning.	K2
CO2	Describe the steps involved in process planning.	K3
CO3	Discuss about cost estimation and Break-Even analysis.	K3
CO4	Estimate the manufacturing cost for welded, forged components and powder metallurgy parts.	K4
CO5	Calculate the machining time and cost for various machining processes.	K3

25WPM5E2	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS *(Use of Approved Design Data Book is permitted)*	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To understand the concepts of press tool design and fixture design for machining and forming systems.

UNIT- I	LOCATING AND CLAMPING PRINCIPLES	(9 Periods)

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– Tolerances and materials used.

UNIT- II	DESIGN OF JIGS	(9 Periods)

Drill bushes – different types of jigs – plate, latch, channel, box, angle plate, post, turnover, pot jigs - Automatic drill jigs - Rack and pinion operated, air operated jigs – Common defects in jig design- design and development of jigs for simple components.

UNIT- III	DESIGN OF FIXTURES	(9 Periods)

Principles of milling, boring, lathe and broaching fixtures - Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- modular fixtures - quick change fixtures - Common defects in fixture design -design and development of fixtures for simple component.

UNIT- IV	PRESS ELEMENTS AND CUTTING DIE DESIGN	(9 Periods)

Press working terminology – types - presses and accessories - tonnage requirements - strip lay out calculations - shearing action - die and punch elements - strippers, knockouts, stops, pilots, selection of standard die sets - design and development of progressive and compound dies for blanking and piercing operations.

UNIT- V	DESIGN OF FORMING AND MISCELLANEOUS DIES	(9 Periods)

Design and development of forming - bending and drawing dies - types - design considerations in forging - extrusion – recent trends in tool design – introduction to computer aids for sheet metal forming analysis.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*P. H. Joshi,* ***"Jigs and Fixtures"****, McGraw Hill Education, 3rd Edition, 2017.*
2	*K. Venkataraman,* ***"Design of Jigs, Fixtures and Press Tools"****, Ane Books Pvt. Ltd., 2nd Edition, 2022.*

REFERENCES:

1	*Cyril Donaldson, H. LeCain George, V. C. Goold and Joyjeet Ghose,* ***"Tool Design"****, McGraw Hill Education, 5th Edition, 2017.*
2	*V. Balachandran,* ***"Design of Jigs, Fixtures & Press Tools"****, Notion Press, 1st Edition, 2015.*
3	*Edward G. Hoffman,* ***"Jigs and Fixture Design"****, Delmar Publishers, 5th Edition, 2004.*
4	*Franklin D. Jones,* ***"Jig and Fixture Design: A Treatise Covering the Principles of Jig and Fixture Design"****, Alpha Edition, 2020.*

5	*P. H. Joshi,* ***"Press Tools: Design and Construction"****, S Chand & Company, 23rd Edition, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know about the about the locating and clamping principles of jigs and fixtures.	K3
CO2	Design and develop various types of jigs for given components.	K6
CO3	Design and develop various types of fixtures for given components.	K6
CO4	Understand the working of press tools and solve problems in strip layout.	K5
CO5	Apply the concepts of die design for forming operations	K5

25WPM5E3	PRODUCT DESIGN AND DEVELOPMENT	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To prepare the students on generic development processes and new product development.

UNIT – I	**INTRODUCTION TO PRODUCT DEVELOPMENT**	**(9 Periods)**

Introduction – Characteristics of Successful Product Development – Product Development Team – Challenges, duration and Cost of Product Development – Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Process Flows – Product Development Organizations – Tournament Structure of Opportunity Identification – Opportunity Identification Process.

UNIT – II	**PRODUCT PLANNING PROCESS**	**(9 Periods)**

Product Planning Process – Identifying Customer Needs – Importance of Latent Needs – Process of Identifying Customer Needs – Definition of Specifications – Time to Establish Specification – Establishing Target Specifications – Setting the Final Specifications.

UNIT – III	**PRODUCT CONCEPT GENERATION AND TESTING**	**(9 Periods)**

Activity of Concept Generation – Concept Selection – Concept Screening – Concept Scoring – Caveats – Concept Testing.

UNIT – IV	**PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN**	**(9 Periods)**

Product Architecture – Definition – Implications – Establishing the Architecture – Delayed Differentiation – Platform Planning – Level Design Issues – Industrial Design – Assessing the Need for Industrial Design – Impact of Industrial Design – Industrial Design Process – Management of the Industrial Design Process – Assessing the Quality of Industrial Design.

UNIT – V	**DESIGN FOR MANUFACTURING AND PROTOTYPING**	**(9 Periods)**

Design for Manufacturing (DFM) – DFM Process: Estimate the Manufacturing Costs – Reduce the Costs of Components, the Costs of Assembly and the Costs of Supporting Production – Impact of DFM Decisions on other Factors – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Ulrich K.T., Eppinger S. D. and Anita Goyal, "**Product Design and Development** "McGraw-HillEducation; 7th edition,2020.*

REFERENCES:

1	*Belz A., 36-Hour Course: "**Product Development**" McGraw-Hill, 2010.*
2	*Chitale, A. K. and Gupta, R. C., **Product Design and Manufacturing**, PHI Learning, 2013.*
3	*Jamnia, A., **Introduction to Product Design and Development for Engineers**, CRC Press, 2018.*
4	*Pugh.S,"**Total Design Integrated Methods for Successful Product Engineering**", Addison Wesley Publishing,1991,ISBN0-202-41639-5.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the principles of generic development process; and understanding the organization structure for new product development.	K3
CO2	Conduct customer need analysis; and to design and set product specification for new product development.	K3
CO3	Generate, select, and test the concepts for new product development.	K3
CO4	Apply principles of product architecture and industrial design for new product development.	K3
CO5	Apply the principles in design for manufacturing and prototyping for new product development.	K3

25WPM5E4	GAS DYNAMICS AND JET PROPULSION *(Use of Approved Gas Tables is permitted)*	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart knowledge on behaviour of compressible flow and propulsion systems.

UNIT- I	BASIC CONCEPTS AND ISENTROPIC FLOWS	(9 Periods)

Energy and momentum equations of compressible fluid flows - Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts –Nozzle and Diffusers.

UNIT- II	FLOW THROUGH DUCTS	(9 Periods)

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – Friction Choking and Consequences, variation of flow properties.

UNIT- III	NORMAL AND OBLIQUE SHOCKS	(9 Periods)

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl Meyer Flow around Concave and Convex Corners, Prandtl – Meyer relations – Applications.

UNIT- IV	JET PROPULSION	(9 Periods)

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, and turbofan and turbo prop engines.

UNIT- V	SPACE PROPULSION	(9 Periods)

Types of rocket engines: Solid, Liquid and Hybrid Propellant Rockets – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity - Applications – space flights.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*E. Rathakrishnan, **"Gas Dynamics"**, Prentice Hall of India Private Limited, 7th Edition, 2020.*
2	*S. M. Yahya, **"Fundamentals of Compressible Flow: with Aircraft and Rocket Propulsion"**, New Age International Publishers, 6th Edition, 2020.*

REFERENCES:

1	*V. Babu., **"Fundamentals of Gas Dynamics"**, Ane Books Pvt. Ltd., 2nd Edition, 2021.*
2	*John D. Anderson, **"Modern Compressible flow"**, McGraw Hill Education, 3rd Edition, 2017.*
3	*George P. Sutton, **"Rocket Propulsion Elements"**, Wiley, 10th Edition, 2017.*
4	*James John, **"Gas Dynamics"**, Pearson, 3rd Edition, 2006.*
5	*V. Babu, **"Fundamentals of Gas Dynamics"**, Springer, 2nd Edition, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of isentropic flow in practical applications.	K3
CO2	Analyze the flow phenomena in ducts.	K3
CO3	Identify and analyze the normal and oblique shocks.	K4
CO4	Design the jet propulsion engine systems.	K4
CO5	Select and design space propulsion systems.	K4

25WPM5E5	WELDING TECHNOLOGY	SEMESTER V

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To study the welding processes, understanding of inspection methods of welded products and also helps to know the material considerations of this operation.	
UNIT – I	**GAS, ARC AND RESISTANCE WELDING PROCESSES**	**(9 Periods)**
Classification and characteristics - Welding processes and Methods - Arc welding processes - SMAW - Electrodes - Gas metal arc welding – Flux cored arc welding – Submerged arc welding – GTAW – Gas Welding - Gas welding equipments, flame characteristics - Principles of Resistance welding – Spot Welding - Seam welding, Seamless welding – Percussion welding.		
UNIT – II	**SPECIAL WELDING PROCESSES**	**(9 Periods)**
Ultrasonic welding - Explosive welding- diffusion welding - Friction welding - Plasma - Transferred welding - Electron beam welding - Laser beam welding - Friction stir welding - Allied welding processes - Brazing and Soldering.		
UNIT – III	**WELDING METALLURGY**	**(9 Periods)**
Weld thermal cycles – Heat Affected Zone (HAZ) – Weldability of carbon steels, Cast Iron, Stainless steel, aluminum and its alloys, Copper, Titanium alloys, low alloy steels and Magnesium - Hydrogen embrittlement – Pro and post weld heat Treatments.		
UNIT IV	**WELDING OF SIMILAR AND DISSIMILAR METALS**	**(9 Periods)**
Welding similar and dissimilar metals - welding of ceramics, composites, micro welding of thin components - Defects in weldments, mechanism - reasons and remedies of cold cracking - hot cracking- reheated cracking and lamellar tearing.		
UNIT V	**DESIGN OF WELD JOINTS, WELDABILITY, INSPECTION AND TESTING OF WELDMENTS**	**(9 Periods)**
Design of weld joints and problems – welding symbols - Testing of welds – quality in weldment – weldability assessment and weldability tests - destructive and NDT evaluation of weldments - procedure for destructive testing - tensile, bending and toughness tests - magnetic particle test - X Ray, gamma, ultrasonic and acoustic tests.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*R. S. Parmer,* ***"Welding Engineering and Technology"****, Khanna Publishers, 3rd Edition, 2013.*
2	*O. P. Khanna,* ***"A Text Book of Welding Technology"****, Dhanpat Rai Publications, 1st Edition, 2015.*

REFERENCES:

1	*S. V. Nadkarni,* ***"Modern Arc Welding Technology"****, Ador Welding Ltd, 2008.*
2	*Richard L. Little,* ***"Welding and welding Technology"****, Tata McGraw Hill Education, 2017.*

3	*Larry F. Jeffus,* ***"Welding: Principles and Applications"****, Delmar Cengage Learning, 7th Edition, 2011.*
4	*Howard B. Cary and Scott C. Helaer,* ***"Modern Welding Technology"****, Pearson Education, 6th Edition, 2005.*
5	*Baldev Raj, V. Shankar and A. K. Bhaduri,* ***"Welding Technology for Engineers"****, Alpha Science International Ltd., 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Provide the principle of the welding process for joints production to the machine products	K2
CO2	Operate the latest and special welding process for uncommon new and specialized components	K3
CO3	Evaluate the physical and chemical properties change due to the welding	K3
CO4	Join the different dissimilar materials as per requirement	K2
CO5	Inspect its quality of welded portion of machine component.	K2

25WPM6E1	HYDRAULICS AND PNEUMATIC CONTROLS	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To develop a measurable degree of competence in the design, construction and operation of fluid power.

UNIT – I	FLUID POWER SYSTEMS AND HYDRAULIC PUMPS	(9 Periods)

Introduction to fluid power - Advantages of fluid power- Application of fluid power system - Types of fluid power systems - Properties of hydraulic fluids – types of fluids – Fluid power symbols - Basics of hydraulics – Applications of Pascal's Law - Losses in pipe, valves and fittings - Pumping theory – Pump classification – Gear, Vane and piston pumps - construction and working of pumps – pump Selection.

UNIT – II	HYDRAULIC CONTROL COMPONENTS AND ACTUATORS	(9 Periods)

Pressure, Flow and Directional control valves - Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, double acting special cylinders like Tandem, Rod less, Telescopic - Cushioning mechanism - Construction of double acting cylinder - Rotary actuators - Gear, Vane and Piston motors.

UNIT – III	DESIGN OF HYDRAULIC CIRCUITS	(9 Periods)

Reciprocating- sequencing – synchronizing - series and parallel circuits – regenerative – pump unloading – double pump circuits – Drilling, Planning, Shaping, Surface grinding hydraulic circuits - Fork Lift application circuit - Intensifier circuits - Fail-safe circuits - Accumulators – Types of Accumulators – Application circuits.

UNIT – IV	PNEUMATIC SYSTEMS AND COMPONENTS	(9 Periods)

Properties of air – Compressors – Filter, Regulator, and Lubricator Unit – Air control valves, Quick exhaust valves, and pneumatic actuators- Control elements – position-pressure sensing – switching- Speed control circuits – Pneumo - hydraulic circuit - Sequential circuit design for simple applications using cascade method, step counter method - Selection of components for pneumatic systems.

UNIT – V	ADVANCEMENTS IN FLUID POWER ENGINEERING	(9 Periods)

Need of automations in industries – PLC - Components of PLC – Applications - Operating Cycle - Types of Programming Languages - Ladder logic diagram – Simple Problems. Servo and proportional valves - Construction, types and applications - Industrial internet of things for monitoring control and diagnostics of systems for fluid power applications.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Md. Abdus Salam,* ***"Fundamentals of Pneumatics and Hydraulics"****, Springer Nature, 1st Edition, 2022.*
2	*S. R. Majumdar,* ***"Pneumatic systems: Principles and Maintenance"****, McGraw Hill Education, 1st Edition, 2017.*

REFERENCES:

1	*R. Srinivasan,* ***"Hydraulics and Pneumatic Controls"****, Vijay Nicole Imprints, 3rd Edition, 2019.*

2	*Mohsen Davoudi and Pouya Karimi,* ***"Pneumatic and Hydraulic Control Systems"****, Noor Publishing, 2017.*
3	*Ilango Sivaraman,* ***"Introduction to Hydraulics and Pneumatics"****, PHI Learning, 3rd Edition, 2017.*
4	*Anthony Esposito,* ***"Fluid Power with Applications"****, Pearson Education India, 7th Edition, 2013.*
5	*T. Jagadeesha,* ***"Hydraulics and Pneumatics"****, I K International Publishing House Pvt. Ltd., 2015.*
6	***"Industrial Hydraulics Manual"****, Eaton Hydraulics Training Services, 5th Edition 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify fluid power systems and select the appropriate pumps for industrial applications.	K3
CO2	Demonstrate the applicability of hydraulic power systems for engineering applications.	K3
CO3	Design customized circuits in hydraulics for various industrial needs.	K3
CO4	Choose pneumatic systems and demonstrate the applicability of pneumatic power systems on real life applications.	K3
CO5	Apply and analyze failure of fluid power systems and to solve them using IoT.	K3

25WPM6E2	COMPUTER AIDED DESIGN AND MANUFACTURING	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To provide an exposure to CAD, CAM and understand the role of computers in modeling and manufacturing.

UNIT – I	INTRODUCTION	(9 Periods)

Fundamentals of CAD/CAM - Product cycle - Design process- sequential and concurrent engineering – Computer graphics - co-ordinate-systems - 2D and 3D transformations - Translation, rotation, scaling, homogeneous coordinates - Line drawing algorithm –Clipping- point, line.

UNIT – II	GEOMETRIC MODELING AND VISUAL REALISM	(9 Periods)

Representation of curves- Hermite curve- Bezier curve- B-Spline curves-rational curves- Surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid Modeling techniques- CSG and B-rep - Model cleanup – visibility technique-sorting-coherence-hidden line removal algorithms Standards for computer graphics- Data exchange standards - IGES, STEP, and CALS.

UNIT – III	GROUP TECHNOLOGY AND FMS	(9 Periods)

Group Technology (GT) - Part Families - Parts Classification and coding system - Production flow Analysis - Cellular Manufacturing - Computer Aided Process Planning - Variant and Generative Process Planning Methods - Types of FMS - Flexibility - FMS Components - FMS Application - Benefits.

UNIT – IV	COMPUTER INTEGRATED MANUFACTURING	(9 Periods)

Fundamentals of NC Technology - Basic Components of an NC System - NC Coordinate Systems- Motion Control Systems -Computers and Numerical Control - CNC Machine Control Unit - CNC Part Programming - G & M code - CIM integration - Distributed Numerical Control - Applications of NC-Machine Tool - Advantages and Disadvantages of NC -Analysis of Positioning Systems - Open-Loop Positioning Systems - Closed- Loop Positioning Systems - Precision in Positioning Systems - Hybrid CNC Machines.

UNIT – V	AUTOMATED MATERIAL HANDLING SYSTEMS	(9 Periods)

Overview of material handling equipments – Consideration in material handling system design – The 10 principles of Material handling, Material transport equipment, Automated Guided Vehicle system – Types &applications – Vehicle guidance technology – Vehicle management and safety - Automated Storage Retrievel System (AS/RS) - Automatic identification method- Bar code Technology, Radio frequency identification, Magnetic stripes, Optical Character Recognition, Machine Vision

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Mikell P. Groover,* ***"Automation, Production Systems and Computer-Integrated Manufacturing"****, Pearson Education, 2016.*
2	*P. Radhakrishnan and S. Subramanyan,* ***"CAD/CAM/CIM"****, New Age International (P) Ltd, 2023.*

REFERENCES:

1	*Donald Hearn and M. Pauline Baker,* ***"Computer Graphics"****, Prentice Hall Inc., 2013.*
2	*David Bedworth,* ***"Computer Integrated Design and Manufacturing"****, TMH, 1998.*
3	*Ibrahim Zeid and R. Sivasubramanian,* ***"CAD/CAM: Theory and Practices"****, McGraw Hill Education, 2nd Edition, 2009.*
4	*Ulrich Sendler,* ***"The Internet of Things: Industrie 4.0 Unleashed"****, Springer, 1st Edition, 2019.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Compute line, 2D and 3D transformation models.	K3
CO2	Generate mathematical representation of solids and familiarize the visual realism and product data exchange techniques.	K3
CO3	Apply knowledge on Group Technology and FMS in shop floor.	K2
CO4	Gain Knowledge on Numerical Control systems	K3
CO5	Understand different material handling systems and choose appropriate one for the industries.	K3

25WPM6E3	NON-CONVENTIONAL ENERGY SOURCES	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To elucidate the technologies used for generation and utilization of power from renewable energy resources.

UNIT- I	SOLAR ENERGY	(9 Periods)

Solar radiation, solar spectra-latitude and longitude, calculation of angle of incidence, angstroms equation and constants, Photo voltaic: p-n junctions, Solar cells, PV systems, Standalone, Grid connected solar power - Types of solar thermal collectors – Flat and concentrating collectors, solar thermal applications - Applications.

UNIT- II	WIND ENERGY	(9 Periods)

Wind energy - Basic principle of wind energy conversion system, wind data and energy estimation, site selection, components of wind energy conversion systems, design consideration of horizontal axis wind mill- merits and limitations- application.

UNIT- III	BIOMASS ENERGY	(9 Periods)

Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - Pyrolysis, gasification, combustion and fermentation. Gasifiers – Up draft, downdraft and fluidized bed gasifier. Digesters- Fixed and floating digester biogas plants, economics of biomass power generation.

UNIT- IV	OCEAN AND GEOTHERMAL ENERGY	(9 Periods)

Ocean energy resources - Principles of ocean thermal energy conversion systems - ocean thermal power plants - Principles of ocean wave energy conversion and tidal energy conversion - Economics of OTEC - Geothermal resources, Utilization for electricity generation and direct heating - Power generating units.

UNIT- V	RENEWABLE ENERGY POLICIES	(9 Periods)

Renewable energy policies - Feed-in tariffs, portfolio standards, policy targets, tax incentives, and biofuel mandates. International policies for climate change and energy security. Economic analysis and comparisons, Life cycle analysis, financial analysis, cost of conserved energy - Cost assessment of supply technologies.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*G. D. Rai,* ***"Non-Conventional Energy Sources"****, Khanna Publishers, 2022.*
2	*N. L. Panwar, Sunil L. Narnaware and Swati Narnaware,* ***"Renewable Energy Sources"****, New India Publishing Agency, 2023.*

REFERENCES:

1	*Roland Wengenmayr and Thomas Buhrke,* ***"Renewable energy: Sustainable energy concepts for the future"****, Wiley-VCH, 1st edition, 2008.*
2	*D. P. Kothari, K. C. Singal and Rakesh Ranjan,* ***"Renewable Energy Sources and Emerging Technologies"****, PHI Learning, 3rd Edition, 2022.*

3	*Mehmet Kanoglu, Yunus A. Cengel and John M. Cimbala,* ***"Fundamentals and Applications of Renewable Energy"****, McGraw Hill, 1st Edition, 2020.*
4	*John Twidell,* ***"Renewable Energy Resources"****, Routledge, 4th Edition, 2021.*
5	*M. K. Singh,* ***"Renewable Sources of Energy"****, Alp Bools, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Realize the need for utilizing the energy from clean and sustainable energy resources.	K3
CO2	Describe the principles of operation of the broad spectrum of renewable energy technologies	K3
CO3	Analyze energy technologies from a systems perspective.	K3
CO4	Articulate the technical challenges for each of the renewable sources.	K3
CO5	Discuss economic, technical and sustainability issues involved in the integration of renewable energy systems.	K4

25WPM6E4	COMPUTATIONAL FLUID DYNAMICS	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To impart knowledge of the basic tools for numerical simulation of fluid flow and heat transfer processes.

UNIT – I	FUNDAMENTALS OF CFD	(9 Periods)

Basics of CFD - Conservation equation – Mass, momentum and energy equations - Conservative forms of the equations and general description - Classification into various types of equations - Elliptic, parabolic and hyperbolic - Initial and boundary conditions - Overview of numerical methods.

UNIT – II	DISCRETIZATION AND FINITE DIFFERENCE METHOD	(9 Periods)

Methods of deriving discretization equations – Comparison of finite difference, Finite volume and finite element techniques - Forward, backward and central difference schemes, transient one- and two-dimensional conduction – Implicit, explicit and Crank Nicolson finite difference methods for viscous flows - Stability analysis and error estimation.

UNIT – III	FINITE VOLUME METHOD	(9 Periods)

Finite volume formulation of steady one-dimensional convection and diffusion problems - Central, upwind, hybrid formulations and comparison for convection-diffusion problems - Discretization equations for two-dimensional convection and diffusion - Representation of the pressure gradient term and continuity equation – Momentum equations – Pressure-velocity coupling - Pressure- correction methods.

UNIT – IV	TURBULENCE MODELING	(9 Periods)

Types of turbulence modeling– Reynolds time averaging – Reynolds-averaged Navier-Stokes equations – Boussinesq eddy viscosity approximation - zero equation model, one equation model, two equation K-I models and advanced models

UNIT – V	GRID GENERATION AND MESHING TECHNIQUES	(9 Periods)

Choice of grid – Grid-oriented and Cartesian velocity components – Staggered and collocated grid arrangements – Structured and unstructured grid generation – Algebraic and differential grid generation methods – Mesh refinement techniques – Adaptive mesh generation – Modern developments in grid generation – Introduction to CFD preprocessing and meshing software tools.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*John D. Anderson Jr,* ***"Computational Fluid Dynamics: The Basics with Applications"****, McGraw Hill Education, Indian Edition, 2017.*
2	*H. Versteeg and W. Malalasekera,* ***"An Introduction to Computational Fluid Dynamics: The finite volume Method"****, Pearson Education Limited, 2nd Edition, 2007.*

REFERENCES:

1	*Dale A. Anderson, John C. Tannehill and Richard H. Pletcher,* ***"Computational Fluid Mechanics and Head Transfer"****, CRC Press, 3rd Edition, 2014.*
2	*Ghoshdastidar, P.S.,* "***Computer Simulation of flow and heat transfer***", *Tata McGraw Hill Publishing Company Ltd., 2017.*

3	*T. J. Chung,* ***"Computational Fluid Dynamics"****, Cambridge University Press, 2nd Edition, 2014.*
4	*Anil W. Date,* ***"Introduction to Computational Fluid Dynamics"****, Cambridge University Press, 2005.*
5	*J. N. Reddy and D. K. Gartling,* ***"The Finite Element Method in Heat Transfer and Fluid Dynamics"****, CRC Press, 3rdEdition, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Appreciate the governing equations of fluid flow and heat transfer used in CFD analysis.	K4
CO2	Apply various discretization techniques for solving engineering problems.	K5
CO3	Analyze numerical solution procedures for convection–diffusion and pressure–velocity coupling problems.	K4
CO4	Evaluate different turbulence modeling approaches used in CFD simulations.	K4
CO5	Develop suitable structured and unstructured grids, adaptive meshes, and utilize CFD preprocessing and meshing software tools for engineering applications.	K4

25WPM6E5	DRONE TECHNOLOGIES	SEMESTER VI

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To inculcate specialized knowledge in an unmanned aircraft system for the societal usage and to introduce the custom design and control of the unmanned aerial vehicle for the future application.

UNIT – I	**INTRODUCTION TO DRONE TECHNOLOGY**	**(9 Periods)**
Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses, Drone business through entrepreneurship – applications of UAV in different field.		
UNIT – II	**DRONE DESIGN AND FABRICATION**	**(9 Periods)**
Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- Pay loads. The energy sources - Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization.		
UNIT – III	**DRONE FLYING AND OPERATION**	**(9 Periods)**
Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone Controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications.		
UNIT – IV	**DRONE COMMERCIAL APPLICATIONS**	**(9 Periods)**
Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing.		
UNIT – V	**FUTURE DRONES AND SAFETY**	**(9 Periods)**
The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization. Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.		

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1	*Daniel Tal and John Altschuld, "**Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation**", 2021 John Wiley & Sons, Inc.*
2	*Reg Austin – "**Unmanned Aircraft Systems: UAVS Design, Development and Deployment**"- Wiley Publications - 2011.*

REFERENCES:

1	*Richard K. Barnhart – "**Introduction To Unmanned Aircraft System"** CRC Press, 2012*
2	*Gundlach. Jay, **"Designing Unmanned Aircraft Systems"** American Institute of Aeronautics and Astronautics, 2012*
3	**John Baichtal, "*Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs*", Que Publishing, 2016**

4	*Zavrsnik, "**Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance**", Springer, 2018*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select and apply various type of drone technology for business	K3
CO2	Apply basic technologies to design UAV system.	K2
CO3	Select appropriate operating conditions for Drones.	K3
CO4	Develop a drone system for specific applications.	K3
CO5	Design the future requirement UAV for application	K3

25WPM7E1	NON-TRADITIONAL MACHINING PROCESSES	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To inculcate specialized knowledge and skill in advanced manufacturing processes with different newer production techniques, influence of their process parameters on performance of machined parts.

UNIT – I	MODERN MACHINING PROCESSES	(9 Periods)

Need of modern machining processes – Classification and selection of technology – mechanical processes - Abrasive jet machining (AJM), Water jet machining (WJM), Ultrasonic machining (USM).

UNIT – II	CHEMICAL METAL REMOVAL PROCESSES	(9 Periods)

Electrochemical machining (ECM), Electrochemical grinding (ECG), Electrochemical deburring and honing – Chemical machining (CHM).

UNIT – III	THERMAL METAL REMOVAL PROCESSES	(9 Periods)

Electric discharge machining (EDM), Wire cut electric discharge machining (WEDM), Plasma arc machining (PAM), Electron beam machining (EBM), Laser beam machining (LBM), Ion beam machining (IBM).

UNIT – IV	NANO FINISHING RPOCESSES	(9 Periods)

Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing

UNIT – V	HYBRID NON-TRADITIONAL MACHINING PROCESSES	(9 Periods)

Introduction to hybrid machining processes – Need and advantages of hybrid machining - Electrostream Drilling (ESD), Shaped Tube Electrolytic Machining (STEM)- Ultrasonic assisted EDM - Laser assisted machining - Electro Chemical Discharge Machining (ECDM)- Micromachining - concepts and applications

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOK:

1	*Helmi Youssef and Hassan El-Hofy,* ***"Non-Traditional and Advanced Machining Technologies"****, CRC Press, 2nd Edition, 2020.*
2	*M. Adithan,* ***"Unconventional Machining Processes"****, Atlantic Publishers and Distributors (P) Ltd., 2018.*

REFERENCES:

1	*P. C. Pandey,* ***"Modern machining processes"****, Tata McGraw Hill publishing company Ltd., 2011.*
2	*Jain, V.K., "****Introduction to micromachining"****, Narosa publishers, 2018*
3	*J. Paulo Davim,* ***"Nontraditional Machining Processes: Research Advances"****, Springer, 2013.*
4	*Golam Kibria, Bhattacharyya B. and Paulo Davim J.*, "***Non-traditional Micromachining Processes: Fundamentals and Applications***", *Springer International Publishing., Switzerland, 2017, ISBN:978-3- 319-52008-7.*
5	*T. Jagadeesha,* ***"Unconventional Machining Processes"****, TechSar Pvt. Ltd., 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the need and application of non-contact latest machining processes resulting in quality and accuracy of parts.	K3
CO2	Apply the knowledge for different ways of metal removal with suitable sources of chemical and electro-chemical energy.	K4
CO3	Discover different thermal energy for metal removal process and optimize appropriate process parameter for different techniques.	K4
CO4	Identify and compare advanced nano-finishing processes and their industrial applications.	K3
CO5	Select suitable hybrid and micromachining processes for advanced engineering and micro-manufacturing applications.	K4

25WPM7E2	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To gain exposure on basic machine learning, clustering and segmentation methods, fuzzy logic, neural networks, RNN and Reinforcement learning.

UNIT – I	**INTRODUCTION TO MACHINE LEARNING**	**(9 Periods)**

Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

UNIT – II	**CLUSTERING AND SEGMENTATION METHODS**	**(9 Periods)**

Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K- nearest neighbors algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

UNIT – III	**FUZZY LOGIC**	**(9 Periods)**

Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application

UNIT – IV	**NEURAL NETWORKS**	**(9 Periods)**

Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics

UNIT – V	**RNN AND REINFORCEMENT LEARNING**	**(9 Periods)**

Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Ethem Alpaydin,* ***"Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)"****, The MIT Press, 4th Edition, 2020.*
2	*Micheal Negnevitsky,* ***"Artificial Intelligence: A Guide to Intelligent Systems"****, Addision Wesley, 3rd Edition, 2011.*

REFERENCES:

1	*Stephen Marsland,* ***"Machine Learning: An Algorithmic Perspective"****, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2nd Edition, 2014.*
2	*Tom M. Mitchell,* ***"Machine Learning"****, McGraw Hill Education, 1st Edition, 2017.*

3	*Trevor Hastie, Robert Tibshirani and Jerome Friedman, "**The Elements of Statistical Learning**", Springer, 2nd Edition, 2017.*
4	*Bruno Siciliano and Oussama Khatib, **"Handbook of Robotics"**, Springer, 2nd Edition, 2016.*
5	*Simon Haykin, **"Neural Networks and Learning Machines: A Comprehensive Foundation"**, Pearson, 3rd Edition, 2016.*
6	*Timothy J. Ross, **"Fuzzy Logic with Engineering Applications"**, Wiley, 3rd Edition, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand basic machine learning techniques such as regression, classification	K2
CO2	Understand about clustering and segmentation	K3
CO3	Model a fuzzy logic system with fuzzification and defuzzification	K3
CO4	Understand the concepts of neural networks and neuro fuzzy networks.	K3
CO5	Gain knowledge on Reinforcement learning.	K3

25WPM7E3	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objective	To provide knowledge on technologies used in Hybrid and Electric vehicles.

UNIT – I	**INTRODUCTION**	**(9 Periods)**

Introduction to electric and hybrid electric vehicles, History of hybrid and electric vehicles, Social and environmental importance of electric and hybrid electric vehicles Electrical basics - Comparison of ICE and EV.

UNIT – II	**ELECTRIC DRIVE COMPONENTS**	**(9 Periods)**

Introduction to electric drive components used in electric and hybrid vehicles, Electric motor requirements, Direct Current (DC) motors (Brushed and Brushless), Power converters, Drive Controllers.

UNIT – III	**DRIVETRAINS AND POWERFLOW**	**(9 Periods)**

Basic concept of electric and hybrid traction, Introduction to various electric and hybrid electric drive train topologies, Advantages and disadvantages, Power flow control in electric and hybrid electric drive train, Generators.

UNIT – IV	**ENERGY STORAGE**	**(9 Periods)**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis. Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT – V	**REGENERATIVE BRAKING SYSTEM**	**(9 Periods)**

Introduction and need of Regenerative Braking System, Advantages and disadvantages of RBS, Working of RBS, Concept of Regenerative Braking using Piezoelectric material, Using shock absorbers vibration as energy harvesters.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Iqbal Hussain,* ***"Electric & Hybrid Vehicles: Design Fundamentals"****, CRC Press, 2nd Edition, 2021.*
2	*James Larminie,* ***"Electric Vehicle Technology Explained"****, John Wiley & Sons, 2nd Edition, 2012.*

REFERENCES:

1	*Chris Mi and M. Abul Masrur,* ***"Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives"****, Wiley, 2nd Edition, 2017.*
2	*Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi,* ***"Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design"****, CRC Press, 1st Edition, 2004.*
3	*Stefano Longo, Mehrdad Ehsani and Yimin Gao,* ***"Modern Electric, Hybrid Electric & Fuel Cell Vehicles"****, CRC Press, 2019.*
4	*Gianfranco Pistoia,* ***"Electric and Hybrid Vehicles: Power Sources, Models,***

	***Sustainability, Infrastructure and the Market"**, Elsevier, 1st Edition, 2010.*
5	*James D. Halderman and Curt Ward, **"Electric and Hybrid Electric Vehicles"**, Pearson Education, 2023.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Select and Apply the electric and hybrid vehicles in routine life.	K2
CO2	Suggest and specify the suitable motor based on the requirements.	K3
CO3	Design the hybrid and electric vehicle power train..	K3
CO4	Select and design a particular and suitable energy storing device.	K3
CO5	Store and utilize the energy harvested from braking system.	K3

25WPM7E4	GREEN SUPPLY CHAIN MANAGEMENT	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To make the students learn and gain an awareness of the different stakeholders involved in green supply chain management.

UNIT – I	INTRODUCTION	(9 Periods)

Basic concepts of green supply chain management - Green supply chain framework - Origins of supply chains - Evolution of supply chains - Traditional to green supply chain - Paradoxes in green supply chain.

UNIT – II	BARRIERS AND GREEN PROCUREMENT	(9 Periods)

Internal barriers - External barriers - Internal motivators and drivers - External motivators and drivers - Green procurement - Factors that contribute to increasing interest in green procurement - Green procurement life cycle - Barriers to broader adoption of green procurement.

UNIT – III	GREEN PRODUCTION AND OUTBOUND LOGISTICS	(9 Periods)

Introduction - Green production design - Green production stages - Green transportation - Green practices in transportation/distribution - European union sustainability guidelines - Expected benefits and challenges of green transportation/distribution.

UNIT – IV	GREEN PACKAGING AND REVERSE LOGISTICS	(9 Periods)

Environmental labeling and labels - Eco-label types - Waste management and environmental policy - Case study: waste electrical and electronic equipment - Case study: excavation, construction and demolition waste management - Decision making methodological framework for construction waste management.

UNIT – V	DECISION MAKING AND TECHNOLOGIES OF MARKETING	(9 Periods)

Introduction to assessment methods - Frameworks and methods - Assessment indicators - Making ICT solutions for managing green practices - Business intelligence - EcoCycle: an easy life cycle analysis tool.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Joseph Sarkis and Yijie Dou* ***"Green Supply Chain Management: A Concise Introduction"****, Routledge, 1st Edition, 2019.*
2	*Mohammed Majeed, Kirti Agarwal and Ahmed Tijani,* ***"Green Supply Chain Management"****, CRC Press, 2024.*

REFERENCES:

1	*Charisios Achillas, Dionysis D. Bochtis, Dimitrios Aidonis and Dimitris Folinas* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2019.*
2	*Venkatesh Ganapathy,* ***"Introduction to Green Supply Chain Management"****, bookboon, 2024.*
3	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management: A Concise Introduction"****, Routledge, 2018.*
4	*Arunachalam Rajagopal,* ***"Green Supply Chain Management: A Practical Approach"****, Replica, 2021.*

5	*Mehmood Khan, Matloub Hussain and Mian M. Ajmal,* ***"Green Supply Chain Management for Sustainable Business Practice"****, IGI Global, 1st Edition, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn about green supply chain management from multiple perspectives.	K3
CO2	Identify the barriers and green procurement.	K3
CO3	Develop the green production, transportation and distribution.	K3
CO4	Identify the environmental labeling and waste management and environmental policy.	K3
CO5	Analyze and compile reports of decision making and various technologies of marketing.	K4

25WPM7E5	ENTREPRENEURSHIP DEVELOPMENT	SEMESTER VII

PREREQUISITES	L	T	P	C
NIL	3	0	0	3

Course Objectives	To identify and apply the concepts of entrepreneurship and behave responsibly and ethically in their role as entrepreneurs in selection of the opportunity and management of resources and utilization of the support from Government and monetary institutions.

UNIT – I	INTRODUCTION TO ENTREPRENEURSHIP	(9 Periods)

Evolution of the concept of entrepreneurship, Characteristics of entrepreneurs, Functions of entrepreneurs, Types of Entrepreneurs, Differences with managers, Growth of entrepreneurship in India, Role of entrepreneurship in economic development, Factors affecting growth of entrepreneurship, Entrepreneurial competencies – Business model canvas.

UNIT – II	START-UP OF ENTREPRENEURIAL VENTURES	(9 Periods)

Opportunity identification and selection, Establishment of incubation centres, Formulation of business plans, Project appraisal methods, Financing of ventures- Sources of finance- Internal and external sources, Forms of ownership, Legal issues of setting of ventures- Patents, Copyrights, trademarks.

UNIT – III	SUPPORT SYSTEM FOR ENTREPRENEURS	(9 Periods)

Institutional support for entrepreneurs- Commercial banks, Other financial institutions, Taxation benefits- Tax holiday, Investment allowance, Rehabilitation allowance, Amortization of certain preliminary expenses, Important provisions of the Industrial Policy Resolution – Government policies- Introduction to proposal writing.

UNIT – IV	MANAGEMENT OF THE VENTURES	(9 Periods)

People Management- Leadership, Motivation, Communication, challenges caused by workforce diversity, Working Capital Management- Assessment of working capital, Factors determining working capital requirement, working capital cycle, Inventory Management- Motives for holding inventories, Methods of inventory management.

UNIT – V	STRATEGIES FOR GROWTH, SUCCESSION PLANNING, ENDING THE VENTURE	(9 Periods)

Growth strategies- Penetration of market, Product development, Market development, Diversification, External sources for growth- Joint ventures, Acquisitions, Mergers and Franchising, Succession planning- Transfer to family members, Selling the business, bankruptcy laws in India.

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1	*Sangeeta Sharma,* ***"Entrepreneurship Development"****, PHI Learning, 2nd Revised edition, 2022.*
2	*M. L. Sharma,* ***"Entrepreneurship Development and Management"****, Khanna Publishers, 1st Edition, 2021.*

REFERENCES:

1	*Bruce R. Barringer and R. Duane Ireland,* ***"Entrepreneurship – Successfully Launching New Ventures"****, Pearson, 6th Edition, 2018.*
2	*Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd and Sabyasachi* ***"Entrepreneurship"*** *McGraw Hill Education, 11th Edition, 2020.*
3	*S. S. Khanka,* ***"Entrepreneurial Development"****, S.Chand & Company Private Limited, 2015.*
4	*Vasant Desai and Kulveen Kaur,* ***"Entrepreneurship: Development and Management"****, Himalaya Publishing House, 2015.*
5	*R. K. Singal,* ***"Entrepreneurship Development & Management"****, S K Kataria and Sons, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Provide an accurate self-analysis for an entrepreneurial career.	K2
CO2	Find an attractive market and decide on the most suitable source of finance for the same.	K3
CO3	Design and develop an entrepreneurial venture that would enjoy the maximum support from financial institutions and the Government.	K3
CO4	Successfully meet the challenges of motivating and communicating with a diverse workforce.	K3
CO5	Find alternative strategies to save a venture that is unable to sustain on its own.	K3