VASAVI COLLEGE OF ENGINEERING(AUTONOMOUS)

Ibrahimbagh, Hyderabad-31

Approved by A.I.C.T.E., New Delhi and
Affiliated to Osmania University, Hyderabad-07

Sponsored by

VASAVI ACADEMY OF EDUCATION

Hyderabad

SYLLABI UNDER CBCS FOR
M.E (MECH) ADVANCED DESIGN & MANUFACTURING
WITH EFFECT FROM 2018-19
(For the students admitted in 2018-19)

DEPARTMENT OF MECHANICAL ENGINEERING

+91-40-23146060, 23146061
Fax: +91-40-23146090
Website: www.vce.ac.in

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION FOR
M.E (MECH) Advanced Design & Manufacturing
I-SEMESTER w.e.f. 2018-19 under CBCS

S. No	Course Code	Course Title	Scheme of Instruction			Scheme of Examination			
			Hours per week			Duration in Hrs	Max.Marks		Credits
			L	T	P		CIE	SEE	
Theory									
1	PI18AC110EH	Audit Course- I: English for Research Paper writing	2	-	-	3	40	60	0
2	PI18PC110MA	Mathematical Methods for Engineers	3	-	-	3	40	60	3
3	PI18PC100ME	Metal Cutting and Forming	3	-	-	3	40	60	3
4	PI18PC110ME	Computer Integrated Design and manufacturing	3	-	-	3	40	60	3
5	PI18PE1X0ME	Professional Elective -1	3	-	-	3	40	60	3
6	PI18PE1X0ME	Professional Elective -2	3	-	-	3	40	60	3
7	PI18PE1X0ME	Professional Elective -3	3	-	-	3	40	60	3
Laboratory									
8	PI18PC111ME	Computer Aided Modelling and Assembly Laboratory	-	-	3	3	50	-	1.5
9	PI18PC121ME	Advanced Manufacturing Laboratory	-	-	3	3	50	-	1.5
10	PI18PC118ME	Seminar I	-	-	2	-	50	-	1
		Total	**20**	**-**	**8**		**430**	**420**	**22**
		Grand Total	**28**				**850**		

DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION FOR
M.E (MECH) Advanced Design & Manufacturing
II-SEMESTER w.e.f. 2018-19 under CBCS

S. No	Course Code	Course Title	Scheme of Instruction			Scheme of Examination			
			Hours per Week			Duration in Hrs	Maximum Marks		Credits
			L	T	P		CIE	SEE	
Theory									
1	PI18AC210EH	Audit Course-II: Pedagogy Studies	2	-	-	3	40	60	0
2	PI18PC240ME	Research Methodology and IPR	2	-	-	3	40	60	2
3	PI18HS200EH	Skill Development Course	2	-	-	3	40	60	2
4	PI18PC210ME	Design for Manufacture and assembly	3	-	-	3	40	60	3
5	PI18PC220ME	Metallurgy of Metal Casting and Welding	3	-	-	3	40	60	3
6	PI18PC230ME	Computer Aided Mechanical Design and Analysis	3	-	-	3	40	60	3
7	PI18PE2X0ME	Professional Elective – 4	3	-	-	3	40	60	3
8	PI18PE2X4ME	Professional Elective – 5	3	-	-	3	40	60	3
Labs									
9	PI18PC231ME	Vibration Analysis Laboratory	-	-	3	-	50	-	1.5
10	PI18PC241ME	Computer Aided Simulation Laboratory	-	-	3	-	50	-	1.5
11	PI18PC218ME	Seminar - II	-	-	2	-	50	-	1
12	PI18PW219ME	Mini Project	-	-	2	-	50	-	1
		Total	**21**	**-**	**10**		**520**	**480**	**24**
		Grand Total	**31**				**1000**		
Foundation Classes : 3 Hours& CCA : 2 Hours									

DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION FOR
M.E (MECH) Advanced Design & Manufacturing
III and IV SEMESTERS w.e.f. 2018-19 under CBCS

III- SEMESTER										
S. No	**Course Code**	**Course Title**	**Scheme of Examination Hours per Week**			**Scheme of Examination**				
			L	**T**	**P**	**Duration in Hrs**	**Maximum Marks CIE**	**SEE**	**Credits**
Theory									
1	PI18OE3XXXX	Open Elective	3	0	0	3	40	60	3
2	PI18PE3X5ME	Professional Elective – 6	3	0	0	3	40	60	3
LABS									
3	PI18PW319ME	Dissertation – Phase I / Internship	0	0	8	-	100	-	4
		Total	**6**	**-**	**8**		**180**	**120**	**10**
		Grand Total	**14**				**300**		
IV-SEMESTER									
1	PI18PW419ME	Dissertation - Phase II / Internship		0	0	24	-	Viva-Voce (Grade)	12
		Total		0	0	24			12
		Grand Total		24					

AC: Audit Courses		
S. No.	**Course Code**	**Course Title**
1	PI18AC110EH	English for Research Paper Writing
2	PI18AC120XX	Value Education
3	PI18AC130XX	Stress Management by Yoga
4	PI18AC140XX	Sanskrit for Technical Knowledge
5	PI18AC210EH	Pedagogy Studies
6	PI18AC220XX	Personality Development through Life Enlightenment Skills
7	PI18AC230XX	Constitution of India
8	PI18AC240XX	Disaster Management

OE: Open Electives		
Sl. No.	**Course Code**	**Course Title**
1	PI18OE310XX	Business Analytics
2	PI18OE320XX	Industrial Safety
3	PI18OE330ME	Operations Research
4	PI18OE340XX	Cost Management of Engineering Projects
5	PI18OE350ME	Composite Materials
6	PI18OE360XX	Waste to Energy

PE: Professional Electives		
Professional Elective-I (Design Group)		
1	PI18PE100ME	Mechanical Vibrations
2	PI18PE110ME	Advanced Kinematics
3	PI18PE120ME	Robotic Engineering
Professional Elective-II (Manufacturing Group)		
1	PI18PE130ME	Flexible Manufacturing systems
2	PI18PE140ME	Quality and Reliability Engineering
3	PI18PE150ME	An Introduction to Nano Science and Technology
Professional Elective-III (Analysis Group)		
1	PI18PE160ME	Finite Element Techniques
2	PI18PE170ME	Experimental Techniques and Data Analysis
3	PI18PE180ME	Fracture Mechanics
Professional Elective-IV (Design Group)		
1	PI18PE200ME	Theory of Elasticity and Plasticity
2	PI18PE210ME	Tribology in Design
3	PI18PE220ME	Mechanics of Composite materials
Professional Elective-V (Manufacturing Group)		
1	PI18PE230ME	Advanced Non Destructive Evaluation Techniques
2	PI18PE240ME	Additive Manufacturing
3	PI18PE250ME	Mechatronics
Professional Elective-VI (Analysis Group)		
1	PI18PE300ME	Optimization Techniques
2	PI18PE310ME	Advanced Finite Element Analysis
3	PI18PE320ME	Computational Fluid Dynamics

DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES
SYLLABUS FOR M.E. (MECH) – I SEMESTER
ENGLISH FOR RESEARCH PAPER WRITING

Instruction: 2 Hours/ week	Semester End Exam Marks: 60	Course Code: PI18AC110EH
Credits: -	CIE Marks : 40	Duration of SEE: 3 Hours

Course Objectives	**Course Outcomes**
Students Should be able to	At the end of the course, students will be able to
• Understand that how to improve your writing skills and level of readability • Learn about what to write in each section • Understand the skills needed when writing a Title	• write research papers • write citations as per the MLA style sheet and APA format • write concisely and clearly following the rules of simple grammar, diction and coherence.

Unit-I: Planning and Preparation, Word Order, Breaking up long sentences. Structuring Paragraphs and Sentences, Being concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit-II: Clarifying Who Did What, Highlighting your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

Unit-III: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit-IV: Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

Unit-V: Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

LEARNING RESOURCES :

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

MATHEMATICAL METHODS FOR ENGINEERS		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PC110MA
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

COURSE OBJECTIVES	COURSE OUTCOMES
The course will enable the students to:	At the end of the course students shall be able to:
1. understand the basic operations of vector operators to prove vector Identities 2. understand the basics of tensors to prove vector identities in tensor form 3. understand the basics of matrices to solve linear algebraic equations 4. understand the concepts of Laplace transforms to solve ordinary differential Equations. 5. classify the PDEs and study the application of PDEs for engineering problems	1. solve the problems by applying the basic operations of vectors to prove vector identities 2. solve the basics of tensors to prove vector identities in tensor form and related problems 3. solve the linear algebraic equations by using methods of matrices. 4. solve differential equations by using the Laplace Transforms. Verify the orthogonality of Functions. 5. solve the PDEs and apply the knowledge for solving engineering problems

UNIT-I : **(11 Periods)**
Vectors: Definition of Scalar–Vector –Scalar point function–Vector point function – Gradient –Divergence – Curl – related problems – Vector Identities – related problems.

UNIT-II : **(12 Periods)**
Tensors:(Cartesian system): Definition – notation – transformation matrix – order of a tensor – Addition, outer product, inner product, contraction and quotient rule on tensors – Kronecker Delta – Definition of Contra variant, Covariant and Mixed tensors –Definition of permutation tensor – Tensor notation of Gradient – Curl and Divergence of vector operators – Tensor notation of Vector identities.

UNIT-III : **(12 Periods)**
Linear algebraic equations: Representation of linear equations in matrix form-Cramer's rule–Inverse of a matrix – Consistence/In–Consistence of equations – Gauss elimination – Gauss-Seidal – LU Decomposition – General solution for under determined system – Least square solutions for over determined systems – Eigen values and Eigen vectors – Singular value decomposition.

UNIT-IV : **(10 Periods)**
Laplace Transforms and Its Applications: Laplace transforms – Properties of Laplace transforms –Inverse Laplace transforms – Convolution theorem – Applications of Laplace transforms to ordinary differential equations – Orthogonal functions – Gram-Schmidt Orthogonalization of vectors.

UNIT-V : **(11 Periods)**
Partial Differential Equations and It Applications : Classification of PDEs – Transformation between different coordinate system – Fourier series – Application of Fourier series to one dimensional wave equation-One dimensional heat equation – Laplace's equation

Suggested Reading:

1 Higher Engineering Mathematics, B.S.Grewal, Khanna Publications
2 Advanced Engineering Mathematics, RK Jain, SRK Iyengar, Narosa Publications
3 Advanced Engineering Mathematics, Kreyszig,8^{th} Edition, John Wiley and Sons Ltd.,2006
4 A Text Book of Engineering Mathematics, N.P.Bali and Manish Goyal, Laxmi Publications
5 Numerical Methods IN Engineering and Science, Dr.B.S Grewal, Khanna Publishers.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

METAL CUTTING AND FORMING		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PC100ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Explain the principles of metal cutting 2. Discuss various shear angle relations 3. Discuss effects of temperature and forces in metal cutting 4. Describe various plastic deformation theories 5. Identify and differentiate various non-conventional forming methods	On completion of the course the student will be able to: 1. analyse various metal cutting processes. 2. formulate equations of temperature distribution and forces in metal cutting. 3. appreciate methods of improving cutting efficiency and economics. 4. evaluate different metal forming methods. 5. analyze various non-conventional forming methods.

UNIT-I

Tool Materials: Tool material properties – HSS, Carbides, coated carbides, ceramic and CBN and diamonds, sialons, powder coatings – Relative advantages. Tool Geometry: Various methods of tool nomenclature and their inter relationship. Theoretical Determination of shear angle and cutting forces: Shear plane theory– Merchants models, Lee and Shofers model. Velocity relations. Estimation of shear angle experimentally. Metal cutting friction. Real area of contact-Rules of dry sliding, stress distribution of tool face-variation of co-efficient of tool face friction with the rake angle.

UNIT-II

Dynamometry: Theoretical and empirical estimation of force and power in turning, drilling, milling and grinding processes optimization in cutting forces – Dynamometer requirements – Force measurements – Electric transducers. Lathe, drilling and milling dynamometers. Cutting Temperatures: Shear Plane temperature – Average chip-tool interface temperature-interface temperature by dimensional analysis – Distribution of shear plane temperature-Measurement of temperature by radiation pyrometer – Moving thermo couple – Photo cell – Photographic method.

UNIT-III

Tool Wear, Tool life and Machinability: Mechanism of tool wear – Adhesive, Abrasive, Diffusive and Chemical wear – Taylor"s tool life equation. Cutting Fluids – Carbon tetrachloride – Direction of fluid application – Chip curl-economics of machining – Comparison of machinability of different metals. Recent development in metal cutting: Hot machining. Rotary machining – High speed machining, rapid proto typing.

UNIT-IV

Plastic Deformation: Mechanism of plastic deformation, Factors affecting plastic deformation, Strain hardening behavior. Recovery, Recrystallization and grain growth. Variables affecting stress-strain curves, Ideal & Practical stress-strain curves. Cold working, warm working and hot working. Plasticity cycle. Plane stress & Plane strain condition. Rolling: Principle of rolling, process parameters. Estimation of rolling loads. Principles of roll pass design for various product shapes. Principles of ring rolling.

UNIT-V

Unconventional Methods In Metal Forming: High energy rate forming. Merits and limitations of HERF Processes. Principle, merits, limitations and applications of pneumatic-mechanical systems. Explosive forming, electro-magnetic forming, electro-hydraulic forming and water hammer forming. Forming with rubber pads – Guerin, Marform & Wheelon forming techniques.

Learning Resources:

1. M.C. Shaw. *Metal cutting principles* – CBS Publications, New Delhi, 1992.
2. Bhattacharya, *Metal cutting* – Central book publishers, Calcutta – 1996.
3. Heinrich Makelt, *Mechanical presses*, Edward Arnold (Pvt) Ltd., London, 1968.
4. Bary. Donald.F and Reads. Edward A., *Techniques of press working sheet metal*, Prentice Hall Publ., 1974.
5. Kameschikov, *Forming Practice*, Mir Publishers, Moscow, 1970.
6. *High Velocity Forming methods*, ASTME, Michigan, 1968.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

COMPUTER INTEGRATED DESIGN AND MANUFACTURING		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PC110ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. understand the present trends of the product cycle. 2. learn the modern manufacturing methods and its programming part. 3. introduce the concepts of modern prototype manufacturing RPT 4. introduce the present shop floor control methods 5. Learn the network methods of the digital devices.	On completion of the course the student will be able to: 1. **understand** the modern methods of design and manufacturing 2. **Distinguish** production planning and control methods in shop floor 3. **Classify** the different additive manufacturing methods 4. **Describe** the modern machining processes 5. **Integrate** the CAD/CAM operations

UNIT-I
Product Design and CAD/CAM in the Production Systems - Product development through CAD and CAE: Geometric modeling techniques using wireframe, surface and solid modeling-graphic standards, Advanced modeling for curves, surfaces, NURBS- Advanced assembly – assembly constraints – subassembly – modification - concepts of engineering analysis and optimization using CAE techniques.

UNIT-II
Advanced Manufacturing Technology – Design drafting interface, Graphic libraries, Computer aided manufacturing technologies using Numerical Control, CNC and DNC, process interface hardware, programming languages, direct digital control, supervisory compiler controls and optical control, adoptive control – Agile and lean manufacturing.

UNIT-III
Rapid proto typing: Various techniques & mathematical background. Automated inspection & RE-engineering techniques: Point cloud data acquisition & analysis.

UNIT-IV
Concepts of Production Planning, Material Requirement Planning, up to down planning and bottom up replanning – Master production scheduling, PPC, Material Handling Requirements, Technology Planning.

UNIT-V
Communication aspects in CIM – Issues in Implementation of Advanced Manufacturing Technology – configuration management, database systems, networking concepts, LAN, MAN, SQL, CIM Models, Economics of CIM.

Learning Resources:

1. MP Groover, "Automation, Production Systems and Computer Integrated Manufacturing", - Pearson Education, 2nd Edition, 2001.
2. Ibrahim Zeid, "CAD/CAM Theory and Practice", - Tata McGraw Hill, 1991.
3. FH Mitchell, "CIM Systems - An Introduction", - Prentice Hall, 1986.
4. Eric Teicholz & JN, "CIM Handbook", - McGraw Hill, 1986.
5. P.N. Rao, "CAD/CAM Principles and Applications", Tata McGraw Hill, 3rd Ed, 2010

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

MECHANICAL VIBRATIONS (PE-I)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE100ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Explain the concept of vibrations, with single and multi-degree freedom 2. Discuss the numerical methods involved in vibrations 3. Demonstrate the concept of Transient vibrations and Random vibrations 4. Identify various methods of vibration control. 5. Describe the concept of Non-Linear vibrations Identify various methods of vibration control.	On completion of the course the student will be able to: 1. **analyse** the multi degree of freedom systems vibrations 2. **formulate** vibration problem using various numerical methods 3. **interpret** the concept of the Random and Transient vibrations 4. **apply** various methods for vibration control 5. **interpre**t the non-linear phenomenon of vibrations and their formulation

Unit-I
(A) Multi Degree Freedom System:-Free Vibration equation of motion. Influence Coefficient i)Stiffness Coeff. (ii) Flexibility Coeff. Generalized co ordinates, and Coordinate couplings. Langranges Equations Matrix Method Eigen Values Eigen Vector problems. Modal Analysis. Forced Vibrations of undamped system and modal analysis.
(B) Multi Degree System Numerical Methods:-(i)Rayleigh`s Method, (ii)Rayleigh-Ritz Method (iii)Holzer`s Method (iv)Methods of Matrix iterations (v) Transfer Matrix Method, Impulse response and frequency response functions.

Unit-II
Continuous System:- Vibrations of String, Bars, Shafts and beams, free and forced vibration of continuous systems.

Unit-III
MODAL PARAMETER EXTRACTION METHODS Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

Unit-IV
Vibration Control:-Balancing of rotating machine, In-situ balancing of rotors, control of natural frequency introduction of damping, vibration isolation & vibration absorbers..Vibration Measurement:- FFT analyzer, vibration exciters, signal analysis. Time domain & Frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and Monitoring, fault diagnosis.

Unit-V
Random Vibrations:- Expected values auto and cross correlation function, Spectral density, response of linear systems, analysis of narrow band systems.
Non Linear Vibrations:-Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase-plane technique, Duffing's equation, jump phenomenon, Limit cycle, perturbation method.

Learning Resources:

1. W T Thomson., " Theory of Vibrations with Applications", CBS Publishers
2. S S Rao, " Mechanical Vibrations", Addison-Wesley Publishing Co.
3. Leonard Meirovitch, " Fundamentals of Vibration", McGraw Hill International Edison.
4. J P Den Hartog, "Mechanical Vibrations", Mc Graw Hill.
5. Srinivasan, " Mechanical Vibration Analysis", Mc Graw Hill.
6. Nuno Manuel Mendes Maia et al," Theoretical and Experimental Modal Analysis", Wiley John & sons, 1999

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

ADVANCED KINEMATICS(PE-I)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE110ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. **study** the graphical and analytical methods to perform kinematic analysis 2. **asses** number and dimensional synthesis of different linkages 3. **learn** D-H convention and transformations to do kinematic analysis of RGGR spatial mechanism 4. **evaluate** the cam and follower mechanism for different motion requirements and their design. 5. **analyze** the methods for kinematic analysis of Two degree of freedom Robot.	On completion of the course the student will be able to: 1. **perform** kinematic analysis of complex mechanisms 2. **demonstrate** principles of kinematic synthesis 3. **analyze** spatial mechanism 4. **design** the cam profile for given required motion of the follower. 5. **perform** kinematic analysis for two degree of freedom Robot manipulator.

Unit-I
Kinematic analysis of plane mechanism: Analytical method of kinematic analysis of four bar mechanisms. Acceleration analysis of complex mechanisms by auxiliary point method. Good man's indirect method.

Unit-II
Kinematic synthesis of linkages: Number synthesis, associated linkage or equivalent linkage concept, dimensional synthesis by analytical and graphical methods.

Unit-III
Kinematic analysis of four link RGGR spatial mechanism, D-H parameters, Transformations matrix method for position velocity and acceleration analysis of special mechanisms.

Unit-IV
Cams: Forces in rigid systems, Mathematical models, Response of a uniform - Motion undamped cam mechanism - Analytical method, Follower response by phase - Plane method - Position error, Jump, Crossover shock - Johnson's numerical analysis

Unit-V
Kinematic analysis of two-degree freedom of Robot, introduction to compliant mechanisms.

Learning Resources:

1. Amitabh Gosh and Ashok Kumar Mallik, '*Theory of Mechanisms and Machines*', Affiliated East-West Press Pvt. Ltd., New Delhi, 1998.
2. Artur, G.Erdman and George.N.Sandor, '*Mechanism Design*', Volume-I and -II, Prentice Hall of India, 1984.
3. Joseph Edward. Shigley and J.Joseph Uicker, '*Theory of Mechanisms and Machines*', McGraw-Hill Company, 1995.
4. RL Norton 'Kinematics and Dynamics of Machines' by McGraw-Hill Company, 1st Ed., 2012
5. Charles E Wilson "Kinematics and Dynamics of Machinery", Pearson, 3rd Edition .

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

ROBOTIC ENGINEERING(PE-I)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE120ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Laws of robotics terms related with robotics, manipulator configurations, types of actuators, applications of robots. 2. Kinematics of robotics and its homogenous transformation matrix. 3. Inverse kinematics and jacobian with singularities and about bug algorithms, trajectory. 4. Dynamics of a robotics and programming methods. 5. Types of sensors including vision.	On completion of the course the student will be able to: 1. **understand** basic concepts of industrial robotics and application of robotics with different manipulator configurations. 2. **model** the motion of robotic systems in terms of kinematics using Denavit-Hartenberg algorithm. 3. **derive** inverse kinematics and jacobian using forward kinematics, trajectory path planning and also sensor based motion planning. 4. **evaluate** dynamics using Largrange_Euler and Newton-Euler methods, controls and robotic programming. 5. **identify** the sensors used for displacement, velocity, acceleration, force and Machine vision

UNIT-I
Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT-II
Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT-III
Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.

UNIT-IV
Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control.

UNIT-V
Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features

Learning Resources:

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4. Steve LaValle, "Planning Algorithms", Cambridge Univ. Press, New York, 2006.
5. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, 2005.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

FLEXIBLE MANUFACTURING SYSTEMS(PE-II)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE130ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	**Course Outcomes**
The objectives of this course are to: 1. set up schemes for machine and accessory layouts for effective manufacture under CIM 2. have a thorough knowledge in part family identification using group technology 3. analyze mathematically the manufacturing situations so as to prevent bottlenecks in manufacture under CIM 4. be in a position to choose the most appropriate material handling scheme of relevance in CIM operations 5. plan for hardware and software for the various computational resources and electronic devices used in FMS	On completion of the course the student will be able to: 1. **interpret** meaning, importance and utility of various layouts 2. **Specify** equipment for FMS operations after detailed study through group technology, process planning and technology planning 3. **Plan** for FMS operations and its schemes using JIT etc. 4. **distinguish** material handling requirements for traditional manufacture and those needed in FMS environment 5. **Specify** the hardware and software requirements and **integrate** different subsystems

UNIT-I

Evolution of Manufacturing Systems: FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing. Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts. Human resources: staff considerations, team work, communication and involvement, the supervisors role, personnel selection, job classifications, employee training.

UNIT-II

Manufacturing's Driving Force: Definition, description and characteristics. Just in-time manufacturing, definition and description, benefits and relationship to FMS, implementation cornerstones, quality and quantity application principles. Single manufacture Cell – design scheduling of jobs on single manufacturing cells. Group Technology: Concepts, classification and coding, benefits and relationship to FMS, design of group technology using rank order clustering technique.

UNIT-III

FMS Design – Using Bottleneck, Extended bottleneck models, Processing and Quality Assurance: Turning centres, Machining centre, construction and operations performed, axes, programming, and format information, work-holding and work-changing equipment, automated features and capabilities, cleaning and deburring – station types and operation description, importance to automated manufacturing, coordinate measuring machines, types, construction and general function, operation cycle description, importance to flexible cells and systems.

UNIT-IV

Automated movement and storage systems–AGVs, Robots, automated storage and retrieval systems, storage space design, queuing carousels and automatic work changers, coolant and chip Disposal and recovery systems, auxiliary support equipment, cutting tools and tool Management – introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, guidelines, work holding considerations, General fixturing, Modular fixturing. FMS and the relationship with workstations – Manual, automated and transfer lines design aspects.

UNIT-V

FMS: computer Hardware, Software, Communications networks and Nanotechnology – general functions, and manufacturing usages, hardware configuration, programmable logic controllers, cell controllers, communications networks. FMS implementation.

Learning Resources:

1. William Luggen, "Flexible Manufacturing Systems", Prentice-Hall, Newjersy, 1991
2. Parrish, D.J., "*Flexible Manufacturing*", - Butter Worths – Heinemann, Oxford, 1993.
3. Groover, M.P., "*Automation, Production Systems and CI"*, - Prentice Hall India, 1989.
4. Kusiak, A., "*Intelligent Manufacturing Systems*", - Prentice Hall, 1990.
5. Ranky, P.G., "Design and Operation of FMS", - IFS Publishers, UK, 1988

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

QUALITY & RELIABILITY ENGINEERING(PE-II)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE140ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. understand the process capability and control charts 2. Analysis the importance of tolerance design 3. Relate QFD and house of quality and its use in product design 4. Apply various techniques to improve reliability systems **5.** Selective maintainability and availability of equipment	On completion of the course, the students will be able to: 1. **understand** importance of quality applications of various control charts and acceptance sampling in quality engineering 2. **estimate** the loss function, and consequence of tolerance design for a product and checking of online quality control 3. **prepare** a house of quality for a product and QFD matrix, importance of ISO and quality circles. 4. **analyze** Various methods to estimate system reliability and how to improve it. Usage of weibull distribution in quality control and reliability **5.** **identify** the best way of maintenance of an equipment, How to increase the availability and economics of reliability engineering.

Unit-I
Quality value and engineering – Quality systems – quality engineering in product design and production process – system design – parameter design – tolerance design quality costs – quality improvement.
Statistical Process Control-x, R, P, C charts, process capability. Acceptance Sampling by variables and attributes, Design of Sampling Plans, Single, Double, Sequential plans.

Unit-II
Loss Function, Tolerance Design – N Type, L Type, S Type; determination of tolerance for these types, nonlinear tolerances. Online Quality Control – Variable Characteristics, Attribute Characteristics, Parameter Design.

Unit-III
Quality function deployment – House of Quality, QFD Matrix, Total Quality Management Concepts. Quality Information Systems; Quality Circles, Introduction to ISO 9000 Standards.

Unit-IV
Reliability – Evaluation of design by tests - Hazard Models; Linear, Releigh, Weibull. Failure Data Analysis System, Reliability, Reliability of series, Parallel Standey Systems; reliability prediction and system effectiveness, reliability prediction based on weibull distribution, Reliability improvement.

Unit-V
Maintainability, Availability, Economics of Reliability Engineering; Replacement of items, Maintenance Costing and Budgeting, Reliability Testing – Burn in testing by binomial, exponential models, Accelerated life testing.

Learning Resources:
1. G Taguchi, '*Quality Engineering in Production Systems*', - McGraw Hill, 1989.
2. W.A. Taylor, '*Optimization & Variation Reduction in Quality*', Tata McGraw Hill, 1991, 1st Edition.
3. Philipposs, '*Taguchi Techniques for Quality Engineering*', McGraw Hill, 1996, 2nd Edition.
4. E.Bala Guruswamy, '*Reliability Engineering*', Tata McGraw Hill, 1994.
5. LS Srinath, '*Reliability Engineering*', Affiliated East West Pvt. Ltd., 1991, 3rd Edition.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

AN INTRODUCTION TO NANO SCIENCE AND TECHNOLOGY (PE-II)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE150ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. **understand** basic fundamentals of nanotechnology 2. **identify** and classify nano materials 3. **explain** synthesis and processing of nano powders 4. **explain** nano, micro fabrication techniques	On completion of the course the student will be able to: 1. **understand** basic fundamentals of nanotechnology and differentiate it from nano science 2. **classify** nano materials and identify their applications 3. **explain** various synthesis and processing steps for nano materials 4. **describe** and use nano, micro fabrication techniques

Unit-I
Introduction: Evolution of science and technology, Introduction to Nanotechnology, Nanotechnology – Definition – Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moores law, Role of Bottom up and top down approaches in nanotechnology, challenges in Nanotechnology.

Unit-II
Nano materials: History of materials, Nanomaterials – Definition, Classification of Nanostructured materials, cause of interest in nanomaterials, some present and future applications of nanomaterials.

Unit-III
Synthesis and processing of nano powders: Processes for producing ultrafine powders – mechanical milling, wet chemical synthesis, gas condensation process, chemical vapour condensation, laser ablation.

Design and Synthesis of self assembled nano structured materials.

Unit-IV
Special nanomaterials, characterization and tools: Carbon nanotubes, nano composites, carbon fullerenes: An overview of preparation, properties applications.
Electron Microscopy Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Probe Microscopy – X ray methods.

Unit-V
Nanoelectronics: Introduction to micro, nano fabrication: Optical lithography, Electron beam lithography, Atomic lithography, Molecular beam epitaxy, MEMS:- Introduction, Principles, Types of MEMS:- Mechanical, Thermal, Magnetic MEMS; Fabrication of MEMS.

Learning Resources:
1. Dieter Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, Second Edition, Wiley, 2013
2. Guozhong Cao, Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, World Scientific, 2011
3. Nitaigour P. Mahalik, Micromanufacturing and Nanotechnology, Springer Science & Business Media, 2006.
4. Mark A. Ratner, Daniel Ratner, Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall Professional, 2003
5. A.S Edelstein, R.C Cammaratra, Nanomaterials: Synthesis, Properties and Applications, Second Edition, CRC Press, 1998.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

FINITE ELEMENT TECHNIQUES(PE-III)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE160ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. equip the students with the Finite Element Analysis fundamentals. 2. enable the students to convert the design problems into FE formulations 3. introduce basic aspects of finite element techniques, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems. 4. familiarise the students with higher order elements and eigen value problems in FET 5. introduce the students to the concepts of 3D finite element analysis and FET software packages.	On completion of the course the student will be able to: 1. **identify** mathematical model for solution of common engineering problems. 2. **formulate** simple problems into finite elements. 3. **solve** structural, thermal, fluid flow problems. 4. **use** professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer. 5. **derive** element matrix equation by different methods by applying basic laws in mechanics and integration by parts. 6. **model** 2D and 3D problems using FEA and work on software to model simple problems

UNIT-I

Introduction to Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Bar Element: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach : Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions.

UNIT-II

Analysis of trusses and frames: Analysis of plane truss. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element.

UNIT-III

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod.
Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors.

UNIT-V

Analysis of a uniform shaft subjected to torsion using Finite Element Analysis. Finite element formulation of three dimensional problems in stress analysis. Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Learning Resources:

1. Tirupathi R Chandraputla and Ashok. D. Belegundu, *Introduction of Finite Element in Engineering,* Prentice Hall of India, 1997.
2. Rao S.S., *The Finite Element Methods in Engineering,* Pergamon Press, 1989.
3. Segerland. L.J., *Applied Finite Element Analysis,* Wiley Publication, 1984.
4. Reddy J.N., *An Introduction to Finite Element Methods,* Mc Graw Hill Company, 1984.
5. Bathe KJ, Finite element Procedures, Prentice Hall of India, 2002

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS(PE-III)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE170ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Understanding measurement of force, temperature, flow measurement 2. Applying the above techniques in experimental setup. 3. Recognise micro-structure & surface measurement techniques 4. Design various experiments and validate using testing method. 5. Introduce Taguchi method and conclude quality loss function	On completion of the course, the Students will be able to: 1. **estimating** force using strain gauges, transducers and strain by photoelasticity, holography, interferometer. 2. **estimating** temperature by electrical resistance, pyrometers thermo couples, biometalic etc and flow measurement by laser dopler, hot wire anemometer, ultrasonic, shadow graphs. 3. **recognise** various microstructure of metals and alloys under different working conditions. Measurement of surface finish. 4. **describe** various hypothesis using t-, F & chi-square test, selection of process parameters and factorial design for experiments, ANOVA to estimate contribution of each parameter. 5. **Applying** orthogonally array for experimental design and optimization of response function, estimating loss function and its applications.

Unit-I

Measurement of cutting forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and Strain measurements by photoelasticity, Holography, interferometer, Moir techniques, strain gauge rosettes.

Unit-II

Temperature Measurement: Circuits and instrumentation for different transducers viz., bimetallic, expanding fluid, electrical resistance, thermister, thermocouples, pyrometers.

Flow Measurement: Transducers for flow measurements of Non-compressible fluids, Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Dopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schilieren photography. Interferometer.

Unit-III

Metallurgical Studies: Optical and electron microscopy, X-ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe.

Surface Measurement: Micro hardness, roughness, accuracy of dimensions and forms. 3-D Co-ordinate measuring machines.

Unit-IV

Experiment design & data analysis: Statistical methods, Randomised block design, Latin and orthogonal squares, factorial design. Replication and randomization.

Data Analysis: Deterministic and random data, uncertainty analysis, test of significance: Chi-square, student's 't' test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

Unit-V

Taguchi Methods: Experimental design and planning with Orthogonal arrays and linear graphs. Additive cause-effect model, Optimization of response level. Identification of Design and noise factors. Performance evaluation and Optimization by signal to noise ratios. Concepts of loss function and its application.

Learning Resources:

1. Jack Philip Holman, Experimental Methods for Engineers, 7th edition, McGraw-Hill, 2001
2. V. C. Venkatesh, H. Chandrasekaran, Experimental Techniques in Metal Cutting, Eastern economy edition, Prentice-Hall of India, 1987
3. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series Analysis: Forecasting and Control, 5th Edition, John Wiley & Sons, 2015
4. Richard C. Dove, Paul H. Adams, Experimental stress analysis and motion measurement: theory, instruments and circuits, techniques, C. E. Merrill Books, 1964
5. Bagchi Tapan P, Taguchi Methods Explained: Practical Steps to Robust Design, Prentice-Hall (India), 1993.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

FRACTURE MECHANICS(PE-III)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE180ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. study different types of fractures 2. study the stress field of elastic crack and its solution. 3. study about the crack growth and crack arrest 4. study about the elastic-plastic fracture mechanics 5. study about the application of fracture mechanics	On completion of the course the student will be able to: 1. **understand** the crack and its effect on the service. 2. **solve** the elastic crack problems 3. **analyse** factors effecting crack growth and its arrest 4. **solve** crack problems using FEM 5. **derive** relationship between fracture design and selection of materials.

Unit-I

Introduction: Crack in a Structure – Griffth Criterion – Cleavage fracture – Ductile fracture – Fatigue Cracking. Service failure analysis.

Unit-II

Elastic Crack: Elastic Crack tip stress field – Solution to crack problems. Effect of finite size stress intensity factor – Special cases – Irwin plastic zone correction. Actual shape of plastic zone – Plane stress – Plane strain.

Unit-III

Energy Principle: Energy release rate – Criterion for crack growth – Crack resistance curve – Principles of crack arrest – Crack arrest in practice.

Fatigue Crack Growth: Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor – Variable amplitude service loading, retardation model.

Unit-IV

Elastic Plastic Fracture Mechanics: Elastic plastic fracture concept – Crack tip opening displacement – J-integral technique; Determination of J-using FEM.

Unit-V

Application of Fracture Mechanics: Fracture design – Selection of materials – fatigue crack growth rate curve – Stress intensity factor range – Use of crack growth law.

Learning Resources:

1. David Broek – Elementary Engineering Fracture Mechanics: Sifth off an Noordhoff Internal Publishers – 1978.
2. John M. Barson and Stanely T. Rolfe: Fracture and Fatigue Control in Structures – Prentice Hall, Inc. USA 1987.
3. Jean Cemative and Jean Louis Chboche Mechanics of Solid Materials, Cambridge University Press, Cambridge, 1987.
4. Prashant Kumar, "Elements of Fracture Mechanics", Wheeler Publications, 1999

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

Computer Aided Modelling and Assembly Laboratory		
Instruction: 3 Hours/ week	SEE Marks: 0	Course Code: PI18PC111ME
Credits: 1	CIE Marks: 50	Duration of SEE: ---

Course Objectives	Course Outcomes
The objectives of this course are to: 1. practice 2D and 3D modelling 2. design and assemble the parts to create mechanical products.	On completion of the course, the Students will be able to: 1. aware the geometric entities and edit for developing 2D drawings. 2. practice the geometric entities to create 3D model. 3. develop assembly of mechanical products by using assembly constraints.

List of Experiments

1. Exercises in Drafting, Modeling and Assembly of Mechanical Components using Parametric and feature based Packages
2. 3 D Part modelling using any of the above packages
3. Development of assemblies for mechanical engineering products
4. Mini Project - Each student has to design minimum two models.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

Advanced Manufacturing Lab		
Instruction: 3 Hours/ week	SEE Marks: 0	Course Code: PI18PC121ME
Credits: 1	CIE Marks: 50	Duration of SEE: -

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Understands the CNC programming. 2. utilize advanced manufacturing technology like additive manufacturing and EDM.	On completion of the course, the Students will be able to: 1. develop the part program for operating CNC lathe and CNC mill. 2. Manufacture the components using 3D printer. 3. Study the characteristics of EDM machining. 4. performance evaluation of drilling operation.

List of Experiments

1. Simulation and development of NC code using CAM software and Manufacture the product on a CNC Lathe
2. Simulation and development of NC code using CAM software and Manufacture the product on a on CNC Milling machine
3. Additive manufacturing of simple components using 3D Printer
4. Generation of characteristic curves on a EDM Machine
5. Study of drilling characteristic using DRILL TOOL Dynamometer

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) I-SEMESTER

SEMINAR-I		
Instruction: 2 Hours/ week	SEE Marks:-	Course Code: PI18PC118ME
Credits: 1	CIE Marks: 50	Duration of SEE: -

Course Objectives	Course Outcomes
The objectives of this course are to: • prepare the student for a systematic and independent study of state of the art topics in a broad area of his / her specialization	On completion of the course, the students will be able to: 1. **write** a suitable abstract 2. **write** a seminar report 3. **present and deliver** a seminar

Seminar *topics* may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Selection of Topics from published Journals / Conference Proceedings in the areas of Design, Manufacturing and Analysis.
- Report to be prepared showing literature survey, organization of material, preparation of PPT and displaying technical writing skills.
- Must display the presentation skills

Each student is required to

1. Submit a one page synopsis of the seminar talk.
2. Give a 20 minutes presentation through OHP, PC, Slide projector followed by a 10 minutes discussions
3. Submit a report on the seminar topic with literature survey

Seminars are to be scheduled from the 3rd week to the last week of the semester and any change in schedule should be discouraged.

The CIE marks will be awarded to the students by at least 2 faculty members on the basis of an oral and a written presentation as well as their involvement in the discussions.

VASAVI COLLEGE OF ENGINEERING(AUTONOMOUS)
DEAPRTMENT OF HUMANITIES AND SOCIAL SCIENCES
M.E - AUDIT COURSE-II SEMESTER
PEDAGOGY STUDIES

Instruction: 2 Hours/ week	Semester End Exam Marks: 60	Course Code: PI18PC210EH
Credits: 0	CIE marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
Students will be able to: 1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers. 2. Identify critical evidence gaps to guide the development.	**Students will be able to understand:** 1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries? 2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners? 3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Unit-I **Introduction and Methodology :**

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

Unit-II • **Thematic overview:**

- Pedagogical practices that are being used by teachers
- in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

Unit-III • **Evidence on the effectiveness of pedagogical practices**

- Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

Unit-IV • **Professional development: alignment with classroom practices and follow-up support**

- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

Unit-V • **Research gaps and future directions**

- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER
RESEARCH METHODOLOGY AND IPR

Instruction: 2 Hours/ week	Semester End Exam Marks: 60	Course Code: PI18PC240ME
Credits: 2	Sessional Marks: 40	Duration of Semester End Exam: 3 hrs.

Course Outcomes
At the end of the course, Students will be able to
• Understand research problem formulation. • Analyze research related information and follow research ethics • Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. • Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. • Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II

Effective literature studies approaches, analysis Plagiarism, Research ethics,

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case
Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES
SYLLABUS FOR M.E. (MECH) – II SEMESTER
SKILL DEVELOPMENT COURSE

Instruction: 2 Hours/ week	Semester End Exam Marks: 60	Course Code: **PI18HS200EH**
Credits: 2	CIE Marks : 40	Duration of SEE: 3 Hours

Course Objectives	Course Outcomes
Students Should be able to	At the end of the course, students will be able to
The four major skills of language learning, listening, speaking, reading and writing provide the right key to success. The main objective of the Skill Development Course curriculum is to involve content for all the above mentioned four skills in teaching English and to get students proficient in both receptive and productive skills.	• Better Comprehension and Presentation Skills • Exposure to Versant, AMCAT and better strike rate during placement • Better Interview Performance

Unit I: **Remedial English: Delightful Descriptions**:
Describing Past, Present and Future Events.

Unit II: **Developing Conversational Skills –** Exchange of pleasantries, Exchange facts and opinions, Using relevant vocabulary.

UNIT III: **Contextual Conversations:** Ask for Information, Give Information, Convey bad news, show appreciation

UNIT IV: **Business English**: **Professional Communication**:
Concise Cogent Communication, Active Listening, Interact, Interpret and Respond. **Expositions and Discussions:** Organization, Key Points, Differing Opinions, Logical conclusions. **Effective Writing Skills:** Structure, Rough Draft, Improvisations and Final Draft for Emails, paragraphs and Essays. **High Impact Presentations:**Structure, Content, Review, Delivery

Unit V: **Industry Orientation and Interview Preparation**
Interview Preparation– Fundamental Principles of Interviewing, Resume Preparation, Types of Interviews, General Preparations for an Interview. **Corporate Survival skills**: Personal accountability, Goal Setting, Business Etiquette, Team Work

Suggested Readings:

1. Business Communication, by Hory Shankar Mukerjee, Oxford/2013
2. Managing Soft Skills for Personality Development by B.N.Gosh, Tata McGraw-Hill/ 2012
3. Personality Development & Soft Skills by Barun K Mitra, Oxford/2011
4. Murphy, Herta A., Hildebrandt, Herbert W., & Thomas, Jane P., (2008) "Effective Business Communication", Seventh Edition, Tata McGraw Hill, New Delhi
5. Locker, Kitty O., Kaczmarek, Stephen Kyo, (2007), "Business Communication – Building Critical Skills", Tata McGraw Hill, New Delhi
6. Lesikar, Raymond V., &Flatley, Marie E., (2005)"Basic Business Communication – Skills for Empowering the Internet Generation", Tenth Edition, Tata McGraw Hill, New Delhi
7. Raman M., & Singh, P., (2006) "Business Communication", Oxford University Press, New Delhi.

Journals / Magazines:

1. Journal of Business Communication, Sage publications
2. Management Education, Mumbai

Websites:

www.mindtools.com
www.bcr.com

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

DESIGN FOR MANUFACTURE & ASSEMBLY		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PC210ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Learn design principles, mechanical properties, geometrical tolerances and economic use of raw materials 2. design metallic components 3. design different casting processes 4. design non-metallic components and study ergonomical aspects 5. design assembled parts	On completion of the course the student will be able to: 1. **select** materials for design 2. **apply** principles for manufacturability for metallic components 3. **describe** design considerations for castings 4. **apply** principles for manufacturability for non metallic components 5. **assemble** the designed parts.

Unit-I

Introduction: General design principles for manufacturability, Introduction to design for manufacturing concepts, mechanical behavior of materials. Materials and design, evolution of engineering materials and their properties. Materials selection charts, selection of engineering materials and their shape. Importance of product specification and standardization.

Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

Unit-II

Metallic Components Design: Metal extrusion, metal stamping, fine blanking, spun metal parts, cold headed parts, extruded parts, rolled formed parts, specialized forming methods, turned parts, drilled parts, milled parts.

Unit-III

Metallic Components Design: Planned and shaped parts, internal ground parts, center less ground, electrical discharged, electro chemical parts. Sand cast, die cast and investment cast.

Unit-IV

Non Metallic Components Design: Thermosetting plastic, injection moulded and rotational moulded parts, blow moulded, ceramics. Thermoformed plastic parts, plastic welding, rubber parts, design for ergonomics, design for quality and reliability, design for X concepts.

Unit-V

Design for assembly: Design for assembly, design for reassembly, design for automated assembly, Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly. Retention, bolted connection, screwed connections, press fitted connections, heat treated parts, product design requirements.

Case Studies: Identification of economical design and redesign for manufacture.

Learning Resources:

1. James G. Bralla, "*Hand book of product design for manufacturing*" McGraw Hill Co., 1999
2. K.G. Swift "*Knowledge based design for Manufacture*", Kogan page Limited, 1987.
3. Ashby. Materials selection in Mechanical Design fourth edition Elsevier, 2011
4. Boothroyd, Geoffrey, Peter Dewhurst, and Winston A. Knight. "Product Design for Manufacture and Assembly", 3rd edition, Fl: Standards media, 2010
5. Swift, K.G., and J.D. Booker. Manufacturing Process Selection Handbook, Butterworth-Heinemann, 2013.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

METALLURGY OF METAL CASTING AND WELDING		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PC220ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. familiarize the concepts of Fe-Fe_3C equilibrium diagram. 2. impart knowledge about metallurgy of ferrous and no ferrous castings. 3. familiarize the concepts of various heat treatment processes. 4. study the welding aspects of various ferrous and non-ferrous alloys. 5. study about the defects in welding process.	On completion of the course the student will be able to: 1. **interpret** metallurgy of casting for ferrous and non ferrous alloys and their heat treatment process. 2. **distinguish** various processes in Welding and related heat treatment processes. 3. **demonstrate** various aspects of welding of alloys of iron, aluminium, magnesium and titanium. 4. **predict** stresses in welding and their relief. **5.** **analyse** the defects in welding processes

UNIT-I
Solidification of pure metals and alloys, phase diagrams.
Metallurgy of Steel and Cast Iron: Iron-Carbon constitutional equilibrium diagram, Solidification microstructure, effect of cooling rate, carbon content. Types of cast irons.

Solidification of Castings: solidification rate and directional solidification, microstructure of cast metals, shrinkage, gases in cast metals, degasification methods.

UNIT-II
Foundry Refractories, malleabilisation. Heat treatment of cast steel, cast iron, age hardening of castings.
Metallurgy of non-ferrous cast alloys: copper base alloys, Aluminium alloys, Magnesium alloys
Zinc based die casting alloys, Nickel chromium high temperature alloys.

UNIT-III
Welding metallurgy – Weld zone, Fusion boundary zone, Heat affected Zone. Heat treatment and related processes in Fusion welding – Annealing, Normalizing, Austempering, martempering stress relieving, Solution treatment.

UNIT-IV
Micro structural products in weldments – Schaeffer diagram, Delta Ferrite, Austenite, pearlite, Martensite. Effect of Alloying elements on weldments. Welding stresses – Residual stresses, effects, methods of relieving.

UNIT-V
Weldability aspects of low alloy steels, stainless steels, aluminium alloys, Magnesium and Titanium alloys.
Weld cracks – cold and hot cracks; Liquation cracks, Hydrogen Induced cracks, Lamellar cracks.

Learning Resources:

1. Taylor, Flemings & Wulff, "Foundry Engineering", N.Y,Wiley & Song Inc, 1993
2. Heine, Richard.W, and others, "Principles of metal casting", Tata McHill, New York, 1983.
3. Udin Funk & Wulff, "Welding for Engineers", N.Y.John Wiley,1954.
4. J.F. Lancaster, "Metallurgy of welding", London, George Allen & Unwio, 1999.
5. R.S. Parmar, "Welding Engineering & Technology", Delhi, Khanna Publishers, 2007.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

COMPUTER AIDED MECHANICAL DESIGN AND ANALYSIS		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PC230ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Explain the design procedure for pressure vessels 2. Discuss the plate bending theories and equations 3. Demonstrate the concept of fracture mechanics 4. Describe the Eigen value problems 5. Identify various methods to perform dynamic analysis	On completion of the course the student will be able to: 1. **analyse** the pressure vessels 2. **formulate** the plate bending equations 3. **interpret** the behaviour of crack and crack propagation 4. **formulate** an Eigen value problem and **develop** its solution 5. **apply** various methods to obtain solutions in Dynamic analysis

UNIT-I
Design of pressure Vessels: Introduction and constructional features of pressure vessels, stresses in pressure vessels, shrink fit stresses in built up cylinders, autofrettage of thick cylinders, thermal stresses and their significance.

UNIT-II
Stresses in flat plates: Introduction, Bending of plate in one direction, Bending of plate in two perpendicular directions, Thermal stresses in plates, Bending of circular plates of constant thickness, Bending of uniformly loaded plates of constant thickness.

UNIT-III
Fracture Mechanics: Introduction, Modes of fracture failure Griffith Analysis, Energy release rate, Energy release rate of DCB specimen; Stress Intensity Factor: SIF"s for edge and centre line crack, Fracture toughness, Elastic plastic analysis through J-integral method: Relevance and scope, Definition of J-integral, Path independence, stress strain relation, Strain Energy Release Rate Vs J-integral.

UNIT-IV
Eigen Value Problems: Properties of Eigen values and Eigen Vectors, Torsional, Longitudinal vibration, lateral vibration, Sturm sequence. Subspace iteration and Lanczo"s method, Component mode synthesis, Eigen value problems applied to stepped beams and bars.

UNIT-V
Dynamic Analysis: Direct integration method, Central difference method, Wilson- method, Newmark method, Mode superposition, Single degree of freedom system response, Multi degree of freedom system response, Rayleigh damping, Condition for stability. (Note: The related algorithms and codes to be practiced by students)

Learning Resources:

1. John, V. Harvey, "Pressure Vessel Design: Nuclear and Chemical Applications", Affiliated East West Press Pvt. Ltd., 1969.
2. Prasanth Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, New Delhi-1999.
3. V. Rammurti, "Computer Aided Mechanical Design and Analysis", Tata Mc Graw Hill-1992.
4. Bathe, J., " Finite Element Procedures", Prentice Hall of India-1996.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

THEORY OF ELASTICITY AND PLASTICITY (PE-IV)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE200ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. enable the student to understand the basic concepts of stress 2. enable the student to understand the basic concepts of strain 3. interpret the stress strain relations and differential equations of equilibrium 4. understand the yeild criteria 5. describe the various flow processes for material deformation	On completion of the course student will be able to : 1. **understand** the mathematical formulation for stress 2. **understand** the mathematical formulation for strain 3. **apply** the stress-strain relations for elastic behaviour to various materials 4. **assess** various yeild criteria and their application 5. **analyse** various plastic flow processes

Unit-I

Basic concepts of stress: Definition, State of stress at a point, stress tensor, invariants of stress tensor, principal stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, deviatoric and hydrostatic components of stress, invariance of deviatoric stress tensor, plane stress.

Unit-II

Basic concepts of strain: Deformation tensor, strain tensor and rotation tensor; invariants of strain tensor, principle strains, derivation for maximum shear strain and planes of maximum shear strain, octahedral shear strain, deviatoric and hydrostatic components of strain tensor, invariance of deviatoric strain tensor, plane strain.

Unit-III

Generalized Hooke's law: Stress-strain relationships for an isotropic body for three dimensional stress space for plane stress and plane strain conditions, differential equations of equilibrium, compatibility equations, material (D) matrix for Orthotropic Materials.

Unit-IV

True stress and true strain, von-Mise's and Tresca yield criteria, Haigh-Westergard stress space representation of von-Mise's and Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle –Reuss and Levy-Mise's constitutive equations of plastic flow, strain hardening theories, work of plastic deformation.

Unit-V

Analysis methods: Slab method, slip line field method, uniform deformation energy method, upper and lower bound solutions. Application of slab method to forging, wire drawing, extrusion and rolling processes.

Learning Resources:

1. Timoshenko and Goodier,– '*Theory of Elasticity*', McGrawHill Publications 3rd Edition 2001.
2. LS Srinath "Advanced Mechanics of Solids", McGraw Hill Publications, 3rd Edition, 2009
3. George E Dieter, Mechanical Metallurgy, McGraw Hill Publications 3rd Ed., 1988
4. J. Chakrabarty, Theory of Plasticity, McGraw Hill Publications, 2nd Edition 1998
5. Alexander Mendelson "Plasticity: Theory and Application", Krieger Publishing Company, 2nd Ed, 1983

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

Tribology in Design(PE-IV)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code : PI18PE210ME
Credits: 3	CIE Marks: 40	Duration of SEE : 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. study the theories of friction and wear 2. design, hydro static, hydro dynamic and elasto hydro dynamic lubricated bearings.	On completion of the course, the student will be able to: 1. apply theories of friction and wear to various practical situations by analysing the physics of the process. 2. understand the various surface measurement techniques and effect of surface texture on Tribological behavior of a surface. 3. select materials and lubricants to suggest a tribological solution to a particular situation. 4. design a hydrodynamic bearing using various bearing charts. 5. understand the recent developments in the field and understand modern research material.

Unit 1
Friction, theories of friction, Friction control, Surface texture and measurement, genesis of friction, instabilities and stick-slip motion.

Unit 2
Wear, types of wear, theories of wear, wear prevention.

Tribological properties of bearing materials and lubricants.

Unit 3
Lubrication, Reynolds's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), Finite Bearings, Design of hydrodynamic journal bearings

Unit 4
Hydrostatic, squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings.

Unit 5
Elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, lubrication of spheres, gear teeth and rolling element bearings, Air lubricated bearings, Tilting pad bearings,

Learning Resources:

1. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
2. Principles in Tribology, Edited by J. Halling, 1975
3. Fundamentals of Fluid Film Lubrication – B. J. Hamrock, McGraw Hill International,1994
4. D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.
5. "Fundamentals of Friction and wear of Materials" American Society of Metals.
6. Introduction to Tribology of Bearings –B. C. Majumdar, A. H. Wheeler &co. pvt. ltd 1985.
7. T.A. Stolarski, "Tribology in Machine Design".

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

MECHANICS OF COMPOSITE MATERIALS (PE-IV)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE220ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Discuss the basic structure of composites 2. Define Elastic constants and Hygro-thermal stresses 3. identify stress-strain relations in composites 4. Describe the behaviour and Design with composites 5. Demonstrate the basic equations of plate bending	On completion of the course the student will be able to: 1. **demonstrate** knowledge of composites and their structure 2. **predict** the Elastic constants and Hygrothermal stresses 3. **analyse** the stress - strain relationship in composites 4. **summarise and apply** the Design procedure and the failure criteria. 5. **formulate** Plate bending equations for various Boundary conditions of composite plates.

Unit-I
Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composite, carbon fibre composites.

Unit-II
Micromechanics of Composites:
Mechanical Properties: Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses.
Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

Unit-III
Macro-mechanics of Composites:
Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

Unit-IV
Strength, fracture, fatigue and design:
Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of liminate composites, Effect of variability of fibre strength.
Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

Unit-V
Analysis of plates and stress:
Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite material. Analysis of composite cylindrical shells under axially symmetric loads.

Learning Resources:

1. Jones, R.M., '*Mechanics of Composite Materials*', Mc-Graw Hill Co., 1967.
2. Calcote, L.R., '*The Analysis of Laminated Composite Structures*', Van Nostrand, 1969.
3. Whitney. I.M., Daniel, R.B. Pipes, '*Experimental Mechanics of Fibre Reinforced Composite Materials*', Prentice Hall, 1984.
4. Hyer. M.W., '*Stress Analysis of Fibre-Reinforced Composite Materials*', McGraw Hill Co., 1998.
5. Carl. T.Herakovich, '*Mechanics of Fibrous Composites*', John Wiley Sons Inc., 1998.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

ADVANCED NON-DESTRUCTIVE EVALUATION TECHNIQUES (PE-V)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE230ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. study the importance of various non-destructive testing method. 2. study different methods to find the surface and subsurface defects in the components 3. study different methods of finding surface, internal defects and properties of the components. 4. study computer aided inspection processes to find defects in components used in medical field 5. study inspection method using light source.	On completion of the course the student will be able to: 1. **understand** the importance and practical applications of various non-destructive methods in industry 2. **evaluate** the surface and sub surface defects of the components produced in industry. 3. **apply** the methods for inspecting surface, internal defects and to find mechanical properties of the components. 4. **select** appropriate computer aided method of inspection of the components depending upon applications 5. **apply** appropriate methods based on light as source of inspection.

Unit-I

Types of defects and characteristics, Quantification aspects relevant for NDE including fracture aspects and stress intensity factors - NDT overview – quality assurance–visual inspection–comparative features of conventional Non destructive Testing and Evaluation Methods including Optical, Radiography, Ultrasonic Testing, Dye penetrate testing, Eddy current testing etc.

Unit-II

Leak testing – liquid penetrant testing – penetrant used – equipment – penetration, emulsification, solvent removal. Eddy current testing – material conductivity – coil impedance–coils and instruments–testing in non-ferromagnetic conducting materials and Ferro magnetic materials – skin effect – frequency used – inspection probes – phase analysis.

Unit-III

Radiography–sources of radiation–shadow formation, enlargement and distortion – recording media – exposures, markers.

Infrared and thermal testing – imaging systems – detectors – analysis methods.

Ultrasonic testing – generation of ultrasound – methodologies – transducers and equipment used – flaw detection - sensitivity and calibration.

Magnetic particle testing–magnetization methods–continuous and residual methods – sensitivity – demagnetization.

Unit-IV

Computer aided image processing methods for radiography and ultrasonic's, tomography in these areas.

Optical techniques of nondestructive evaluation: Principles of Photo elasticity, holographic Interferometry and Laser speckle techniques; use of fibre optics, non-invasive techniques in medical field and NDT.

Unit-V

Machine Vision-system components, Sensors, specifications for resolution & range.

Grid and Moire NDT, acoustic, shearography, Principles of Microwave, acoustic emission techniques.

Learning Resources:

1. Barry Hull, '*Non-Destructive Testing*' –Vernon John, ELBS/ Macmillan, 1988.
2. Baldev Raj, T.JayaKumar, M.Thavansimuthee, '*Practical Non-Destructive Testing*', - Narosa Publishing House, New Delhi, 1997.
3. Journals: British Journal of NDT, Materials Evaluation, ISNDT Journal.
4. ASM Handbook: Non-Destructive Evaluation and Quality Control, ASM International, Vol. 17, 1989
5. Ravi Prakash, Non-Destructive Testing Techniques, New Age Science, 2009

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

ADDITIVE MANUFACTURING(PE-V)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE240ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. understand the importance of RPT 2. Apply various liquid and solid based RPT Systems 3. Apply various powder based RPT systems and rapid tooling 4. Recognize various STL formats and slicing methods and tessellation 5. Application of RPT in Engineering, Jewelry and Bio medical etc.	On completion of the course the student will be able to: 1. **understand** the developments of RPT and its terminology, Advantages and limitations of RPT 2. **understand** mechanism involved in stereo lithography apparatus system, and terminated object manufacturing, fused deposition modeling and their applications. 3. **understand** mechanism in selective laser interims and its application. Understand the importance of Rapid tooling 4. **recognize** various types of file format and slicing methods in RP and various software available to convert 3D models. 5. **apply** RPT in various fields like Engineering, Jewelry, medical and Bio – Medical Engineering

Unit-I

Introduction: Prototyping fundamentals, Historical development, fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used terms, classification of RP process, Rapid prototyping process chain: Fundamental Automated processes, process chain.

Unit-II

Liquid based rapid prototyping systems: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Solid based rapid prototyping systems: Laminated object manufacturing (LOM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modeling (FDM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Unit-III

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs Rt, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, investment casting, spin casting, die csting, sand casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

Unit-IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and invalid tressellated models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats.

Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, view expert, 3 D view, velocity 2, Rhino, STL view 3 data expert and 3 D doctor

Unit-V

RP Applications: Application – Material Relationship, application in design, application in engineering, Analysis and planning, aerospace industry, automatic industry, Jewelry industry, coin industry, GIS application, Arts and Architecture. **RP Medical and Bioengineering Application:** Planning and simulation of complex surgery, customized implant and prosthesis, design and production of medical devices, forensic science and anthropology, visualization of biomolecules.

Learning Resources:

1. Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles an Applications, World Scientific publications, 3rd Ed., 2010
2. D.T. Pham and S.S. Dimov, "Rapid Manufacturing", Springer, 2001
3. Terry Wohlers, " Wholers Report 2000", Wohlers Associates, 2000
4. Paul F. Jacobs, " Rapid Prototyping and Manufacturing"–, ASME Press, 1996
5. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

MECHATRONICS (PE-V)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE250ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Understand key elements of Mechatronics system, representation into block diagram 2. Understand concept of transfer function, reduction and analysis 3. Understand principles of sensors, its characteristics, interfacing with DAQ microcontroller 4. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application 5. Understand the system modeling and analysis in time domain and frequency domain	On completion of the course, the students will be able to: 1. Identification of key elements of mechatronics system and its representation in terms of block diagram 2. Understand the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O 3. Interface the Sensors, Actuators using appropriate DAQ micro-controller 4. study time and Frequency domain analysis of system model (for control application) 5. Develop PLC ladder programming and implementation of real life system

Unit – I
Introduction to Sensors & Actuators: Introduction to Mechatronics, Measurement characteristics: - Static and Dynamic Sensors: Position Sensors: - Potentiometer, LVDT, Encoders; Proximity sensors:- Optical, Inductive, Capacitive; Motion Sensors:- Variable Reluctance; Temperature Sensor: RTD, Thermocouples; Force / Pressure Sensors:- Strain gauges; Flow sensors: - Electromagnetic Actuators: Stepper motor, Servo motor, Solenoids

Unit – II
Block Diagram Representation: Open and Closed loop control system, identification of key elements of mechatronics systems and represent into block diagram (Electro-Mechanical Systems), Concept of transfer function, Block diagram reduction principles, Applications of mechatronics systems:- Household, Automotive, Shop floor (industrial).

Unit – III
Data Acquisition & Microcontroller System: Interfacing of Sensors / Actuators to DAQ system, Bit width, Sampling theorem, Aliasing, Sample and hold circuit, Sampling frequency, ADC (Successive Approximation), DAC (R-2R), Current and Voltage Amplifier.

Unit – IV
PLC Programming: Introduction, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming, Introduction to SCADA system

Unit –V
Modelling and Analysis of Mechatronics System: System modeling (Mechanical, Thermal and Fluid), Stability Analysis via identification of poles and zeros, Time Domain Analysis of System and estimation of Transient characteristics: % Overshoot, damping factor, damping frequency, Rise time, Frequency Domain Analysis of System and Estimation of frequency domain parameters such as Natural Frequency, Damping Frequency and Damping Factor

Learning Resources:
1. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008
2. Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall, 2009
3. Alciatore &Histand, Introduction to Mechatronics and Measurement system, 4th Edition, Mc-Graw Hill publication, 2011.
4. Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006.
5. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

Vibration Analysis Laboratory		
Instruction: 3 Hours/ week	SEE Marks: 0	Course Code: PI18PC231ME
Credits: 1	CIE Marks: 50	Duration of SEE: ---

Course Objectives	Course Outcomes
The objectives of this course are to: 1. understand motion characteristics in rotating mass system. 2. Analyze the damped, undamped vibration system. 3. understand vibration response characteristics and stability of dynamic systems. 4. data acquisition and analysis of the vibration signals.	On completion of the course, the Students will be able to: 1. evaluate the static and dynamic balancing of masses. 2. analyze the response of dynamic systems under dynamic loading. 3. analyze the spring mass system with and without damping. 4. Analyze the vibration data through data acquisition system. 5. analysis of mechanical systems using simulation software.

List of Experiments

1. To find the static and dynamic balancing masses in a rotating mass system.
2. To study the damped and un damped forced vibration system
3. To study the torsional vibration response characteristics using single and two rotor system
4. Determination of critical speed of the given shaft with the given end conditions. (Whirling of Shafts)
5. To study frequency response of spring mass system with and without damping.
6. To study frequency response with random excitations (Seismic response).
7. Vibration analysis of a cantilever beam and its data acquisition using LAB-VIEW
8. Analysis of acquired data using LAB-VIEW
9. Mechanical system simulation using MATLAB

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

Computer Aided Simulation Laboratory		
Instruction: 3 Hours/ week	SEE Marks: 0	Course Code: PI18PC241ME
Credits: 1	CIE Marks: 50	Duration of SEE: ---

Course objectives	Course Out comes
The objectives of this course are to: 1. understand the CAE software applicability for analyzing structural problems. 2. analyze non linear behaviour of structural members. 3. kinematic analysis of mechanical systems.	***On completion of the course, the student will be able to:*** 1. select appropriate finite element for solving structural problems. 2. analyze non linear behaviour of mechanical components and metal forming operation. 3. analysis of mechanisms like 4 bar mechanism, spring damper and projectile motion.

List of Experiments

1. Introduction to FEA software - Analysis using 1-d bar elements.
2. Analysis if Trusses and Beams
3. Analysis of Plane stress and Plane strain
4. Modal, harmonic and transient Analysis of Beams.
5. Non Linear small displacement analysis of a Beam
6. Non linear large displacement analysis of a Hose Clamp
7. Plastic deformation Analysis in metal forming operation
8. Analysis of a 4 bar mechanism using simulation software
9. Analysis of Spring damper and Projectile motion

Note: The above experiments are to be conducted using all the available softwares in the Department.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

SEMINAR-II		
Instruction: 2 Hours /week	SEE Marks: -	Course Code: PI18PC218ME
Credits: 1	CIE Marks: 50	Duration of SEE: -

Course Objectives	Course Outcomes
The objectives of this course are to: • prepare the student for a systematic and independent study of state of the art topics in a broad area of his / her specialization	On completion of the course, the students will be able to: 1. **write** a suitable abstract 2. **write** a seminar report 3. **presentation** of the seminar

Seminar *topics* may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Selection of Topics from published Journals / Conference Proceedings in the areas of Design, Manufacturing and Analysis.
- Report to be prepared showing literature survey, organisation of material, preparation of PPT and displaying technical writing skills.
- Must display the presentation skills

Each student is required to

1. Submit a one page synopsis of the seminar talk.
2. Give a 30 minutes presentation through OHP, PC, Slide projector followed by a 10 minutes discussions
3. Submit a report on the seminar topic with literature survey

Seminars are to be scheduled from the 3rd week to the last week of the semester and any change in schedule should be discouraged.
The CIE marks will be awarded to the students by at least 2 faculty members on the basis of an oral and a written presentation as well as their involvement in the discussions.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) II-SEMESTER

Mini Project		
Instruction: 2 Hours /week	SEE Marks: -	Course Code: PI18PW219ME
Credits: 1	CIE Marks: 50	Duration of SEE: -

Course Objectives	Course Outcomes
The objectives of this course is to: enable the student to take up investigative study in the field of design, analysis and manufacturing engineering.	**On completion of the course, the student will be able to:** 1. Choose appropriate problem in design, analysis and manufacturing areas. 2. Plan the activities for carrying out the work in teams. 3. Develop the capability to conduct investigations on the chosen problem using the mechanical engineering tools. 4. present the work carried out for evaluation.

The mini project can be assigned on individual basis or in a group consisting of maximum 2 students/ batch.
The students are required to identify the topic of their interest and collect data / literature in core areas of design, analysis and manufacturing engineering. The students need to identify a problem and work in that area in consultation with the project guide. The output may be in terms of a small prototype or conducting investigations through experiments or evaluate theoretically using modern tools of mechanical engineering using modelling and analysis tools.

The students are required to submit a project report containing the abstract and the summary of the work in terms of plots or fabricated models and submit for evaluation.

The students are required to give a oral presentation/ demo of prototype before the departmental committee for evaluation.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) - III semester

OPERATIONS RESEARCH (OPEN ELECTIVE)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18OE330ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. understand the application of mathematics for real time problem solving to LPP 2. sensitivity analysis under set of constraints 3. applying mathematical techniques to solve transportation problem and assignment problems 4. applying Johnsons rules to find the best sequence to minimize elapsed time. 5. understand CPM & PERT for project scheduling and control.	On completion of the course, the student will be able to: 1. format the practical problems into LPP and solve it by mathematical techniques (graphical &simplex) and apply the solution to the problem 2. obtain solution to LPP by Dual simplex, sensitivity analysis with restrictions. 3. implement transportation technique to get initial solutions and optimal solution. 4. optimal sequencing to minimum elapsed time for processing of n jobs on m machines. 5. apply the techniques like CPM and PERT for project management.

Unit-I
Introduction: Definition and scope of operations research.
Linear programming: Introduction, Formulation of linear programming problems, graphical method of solving LP problem, Simplex method, maximization and minimization, degeneracy in LPP, unbounded and Infeasible solutions.

Unit-II
Duality: Definition, Relationship between optimal primal and dual solutions. Economic interpretation, Post optimal analysis (restricted to variation of resources i.e., RHS), Dual simplex method.

Unit-III
Transportation model: Finding an initial feasible solution– north west corner method, least cost method, Vogel's approximation method, finding the optimal solution, optimal solution by stepping stone and MODI methods, special cases in transportation problems – Unbalanced transportation problem.
Assignment Problem: Hungarian method of assignment problem, maximization in assignment problem, unbalanced problem, problems with restrictions, travelling salesman problems

Unit-IV
Sequencing models: introduction, general assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines processing 2 jobs through m machines.

Unit-V
Project Scheduling:
Introduction to network analysis, Rules to draw network diagram, Fulkerson rule for numbering events, Critical path method, PERT.

Learning Resources:

1. S S Rao, "Engineering optimisation – Theory and Practice", 4th Edition, John Wiley & Sons Inc., 2009 .
2. Hamady A. Taha, "Operations Research – An introduction", 6th Ed., PHI Pvt. Ltd., 1997.
3. S.D. Sharma, "Operations Research", Kedarnnath, Ramnath & Co., Meerut, 2009.
4. Harvey M. Wagner, "Principles of Operations Research", 2nd Ed., PHI Pvt. Ltd., 1980.
5. Pannerselvam, "production and Operations Management", Pearson Education, 2007

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) - III semester

COMPOSITE MATERIALS (OPEN ELECTIVE)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code : PI18OE350ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. discuss the basic structure of composites 2. define Elastic constants and Hygro-thermal stresses 3. identify stress-strain relations in composites 4. describe the behaviour and Design with composites 5. demonstrate the basic equations of plate bending	On completion of the course the student will be able to: • **demonstrate** knowledge of composites and their structure • **predict** the Elastic constants and Hygrothermal stresses • **analyse** the stress - strain relationship in composites • **summarise and apply** the Design procedure and the failure criteria. • **formulate** Plate bending equations for various Boundary conditions of composite plates.

Unit-I
Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composite, carbon fibre composites.

Unit-II
Micromechanics of Composites:
Mechanical Properties: Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses.
Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

Unit-III
Macro-mechanics of Composites:
Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

Unit-IV
Strength, fracture, fatigue and design:
Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of liminate composites, Effect of variability of fibre strength.
Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

Unit-V
Analysis of plates and stress:
Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite material. Analysis of composite cylindrical shells under axially symmetric loads.

Learning Resources:

1. Jones, R.M., '*Mechanics of Composite Materials*', Mc-Graw Hill Co., 1967.
2. Calcote, L.R., '*The Analysis of Laminated Composite Structures*', Van Nostrand, 1969.
3. Whitney. I.M., Daniel, R.B. Pipes, '*Experimental Mechanics of Fibre Reinforced Composite Materials*', Prentice Hall, 1984.
4. Hyer. M.W., '*Stress Analysis of Fibre-Reinforced Composite Materials*', McGraw Hill Co., 1998.
5. Carl. T.Herakovich, '*Mechanics of Fibrous Composites*', John Wiley Sons Inc., 1998.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) III-SEMESTER

OPTIMIZATION TECHNIQUES (PE-VI)		
Instruction: 3 Hours/ week	SEE Marks: 60	Course Code: PI18PE300ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. Understand linear programming & transportation & sensitivity analysis 2. Compute non L.P and unconstrained optimization. 3. Compute the non L.P.P and constrained optimization. 4. Apply principle of optimality in dynamic programming and integer programming 5. Apply CPM & PERT for project scheduling and control.	On completion of the course, the Students will be able to: 1. **explain** simplex, dual simplex and revised simplex & sensitivity analysis and transportation and their applications for shop floor problems. 2. **apply** of non LPP like unconstrained method univariate method, steepest descent conjugate gradient, quasi Newton method. 3. **apply** Lagrange multiplier, Kuhn-Tucker conditions, Beal's method penalty, Function for constrained optimization problems. 4. **describe** the importance of dynamic principles and its applications like Cargo loading, product scheduling and forecasting. Integer programming like branch and bound and Gromery's cutting plane method. 5. **apply** the project management techniques like CPM & PERT

Unit-I
Linear Programming:
Statement of Optimization Problem, Linear Programming: Simplex method, revised simplex method, sensitivity analysis and transportation problems.

Unit-II
Non Linear Programming unconstrained optimization:
Nonlinear programming approach, convergence and scaling of design variables;
Unconstrained optimization direct search methods**:** Random Search, Univariate, Pattern search, Powell Method, Hook – Jeeves algorithm ;.
Non linear unconstrained optimisation indirect Search methods: Steepest Descent, Conjugate Gradient, Newton, Quasi Newton.

Unit-III
Non Linear Programming constrained optimization
Nonlinear programming constrained optimization direct methods: Lagrange multipliers, Kuhn-Tucker conditions, Beal's method, indirect method: Penalty function and applications

Unit-IV
Dynamic Programming:
Introduction to dynamic programming; Concept of sub optimization and the principle of optimality; Linear and continuous dynamic programming with applications; Introduction to integer programming; Cutting plane method; Branch and bound method; Introduction to genetic algorithms, particle swarm optimization.

Unit-V
Project scheduling: PERT-CPM, Probability and cost consideration in project scheduling; Crashing analysis, Resource allocation, Resource levelling.

Learning Resources:

1. Rao, S.S., 'Engineering Optimization Theory and Practice', New Age Int. Pub., 3rd Ed., 1996
2. Deb, K., "Optimization for Engineering Design", Prentice Hall of India, 1995.
3. Haug, E.J. and Arora, J.S., 'Applied optimal design' Wiley Inter Science Publication, NY, 1979
4. Douglas J. Willde, 'Globally optimal design' Jhon Wiley & Sons, New York, 1978
5. S.D. Sharma, 'Operations Research', Khanna Publications, 2001
6. David Goldberg, Genetic Algorithms, pearson publications, 2006

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) III-SEMESTER

ADVANCED FINITE ELEMENT ANALYSIS (PE-VI)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE310ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course is to: 1. understand basic theory of plates and shells 2. interpret the concept of non-linearity 3. familiarize with the numerical methods in dynamic analysis 4. understand fluid flow and heat transfer analysis 5. familiarize with adaptive meshing and error estimates	On completion of the course, the Students will be able to: 1. identify the FE formulations for plates and shells 2. formulate the non-linear problems. 3. calculate dynamic characteristics using numerical methods 4. formulate the fluid flow and heat transfer analysis. 5. estimate the errors and convergence rates

Unit-I
BENDING OF PLATES AND SHELLS : Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements- Application and Examples.

Unit-II
NON-LINEAR PROBLEMS : Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure-Application in Metal Forming Process and Contact Problems.

Unit-III
DYNAMIC PROBLEM : Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit &Implict Methods- Lanchzos, Reduced method for large size system equations.

Unit-IV
FLUID MECHANICS AND HEAT TRANSFER : Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

Unit-V
ERROR ESTIMATES AND ADAPTIVE REFINEMENT : Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

Learning Resources:
1. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
2. Cook R.D., "Concepts and Applications of Finite Element Analysis",John Wiley and Sons Inc., Newyork, 1989.
3. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990
4. S.S.Rao, "Mechanical Vibrations" Addison-Wesley publishing co. 1998
5. V. Rammurti "computer aided mechanical design and analysis" Tata Mc-Grawhill 1992

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) III-SEMESTER

COMPUTATIONAL FLUID DYNAMICS(PE-VI)		
Instruction: 3 Hours / week	SEE Marks: 60	Course Code: PI18PE320ME
Credits: 3	CIE Marks: 40	Duration of SEE: 3 hrs.

Course Objectives	Course Outcomes
The objectives of this course are to: 1. develop an understanding for the major theories, approaches and methodologies used in CFD. 2. build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.) 3. gain experience in the application of CFD analysis to real engineering designs	On completion of the course the student will be able to: 1. **solve** differential equations for flow phenomena and heat transfer 2. **familiarize** with the turbulence models and types of partial differential equations. 3. **describe** the major theories, approaches and methodologies used in CFD 4. **use** and **develop** flow simulation code for the flows in engineering and science using FDM. 5. critically **analyze** different solvers and grid generation techniques 6. **use** and **develop** flow simulation code for the flows in engineering and science using FVM

Unit– I

Review of the basic fluid dynamics: Continuity, Momentum and Energy equations Navier Stokes equations. Heat transfer conduction equation for steady and un–steady flows, steady convection– diffusion equation.

Unit– II

Introduction to turbulence, Reynolds averaged N–S equations, Mixing length model, K–epsilon turbulence model, Favre averaged N–S equations. Classification of partial differential equations – Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems.

Unit– III

Concepts of Finite difference methods– forward, backward and central difference. examples: 1-D steady state heat conduction without and with constant source term 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme; Errors, consistency, stability analysis – Von Neumann analysis, convergence criteria; Viscous incompressible flow, stream function– Vorticity method.

Unit– IV

Solution techniques for systems of linear algebraic equations: Elimination method: Forward elimination and backward substitution, Tridiagonal matrix algorithm (TDMA): Thomas algorithm, Iteration methods: Jacobi's method and Gauss Siedel method and ADI methods.
Introduction to grid generation, Structured and Unstructured grids, Types of grid – O,H,C.

Unit– V

Introduction to finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows staggered grid, SIMPLE Algorithm.

Suggested Reading:

1. Pradip Niyogi, Chakrabartty SK, Laha M K,'Introduction to Computational Fluid Dynamics', Pearson Education, 2005.
2. Muralidhar K, Sundararajan T,'Computational Fluid Flow and Heat Transfer',Narosa publication House, New Delhi, 2003
3. Chung T J, 'Computational Fluid Dynamics, Cambridge University Press, New York, 2002
4. John D Anderson, 'Computational Fluid Dynamics', Mc Graw Hill Inc., New York, 2003
5. Patankar S V,'Numerical Heat Transfer and Fluid Flow', Hemisphere Publishing Company, New York 1980
6. H.K. Versteeg, W. Malalasekara, An Introduction to computational Fluid Dynamics, Pearson Education, 2nd Ed.2007.

Web resources:

1. http://nptel.ac.in/courses/103106073 & 112104030 & 112105045 & 112107080
2. http://freevideolectures.com/Course/3486/Introduction-to-CFD

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) III-SEMESTER

Dissertation - Phase I		
Instruction: 8 Hours /week	SEE Marks: ---	Course Code: PI18PW309ME
Credits: 4	CIE Marks: 100	Duration of SEE: ----

Course Objective	**Course Outcomes**
The objective of this course is to: • Start with a suitable Dissertation work in consultation with the supervisor in the areas of his/her specialization either in the Institute or Industry.	On completion of the course, the students will be able to: 1. apply and Solve the problems in the relevant field of specialization from the knowledge gained from theoretical and practical courses pursued during the course. 2. Develop the capability to conduct investigations on the chosen problem. 3. Develop flair for R&D work.

- A research project topic may be selected either from published lists or from the creative ideas of the students themselves in consultation with their project supervisor.
- To improve the student research and development activities.

The CIE marks will be awarded to the students by at least 2 faculty members and the supervisor on the basis of an oral presentation and submission of a progress report.

DEPARTMENT OF MECHANICAL ENGINEERING
SYLLABUS FOR M.E. (AD&M) IV-SEMESTER

Dissertation - Phase II		
Instruction: 24 Hours /week	SEE Marks: ---	Course Code: PI18PW409ME
Credits: 12	CIE Marks: -	Duration of SEE: ----

Course Objectives	**Course Outcomes**
The objectives of this course are to: • Complete the Dissertation work in line with the chosen field in the areas of his/her specialization.	On completion of the course, the students will be able to: 1. Prepare a thesis with all the findings in the chosen area. 2. Present a seminar with all the results during the Viva-voce examination.

The final assessment involves presentation of the dissertation work by the student and the award of the grade by an expert of relevant specialization.