VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18ME71	Control Engineering		3	--	--	03	40	60	100	3
2	PCC	18ME72	Computer Aided Design and Manufacturing		3	--	--	03	40	60	100	3
3	PEC	18ME73X	Professional Elective - 2		3	--	--	03	40	60	100	3
4	PEC	18ME74X	Professional Elective - 3		3	--	--	03	40	60	100	3
5	OEC	18ME75X	Open Elective -B		3	--	--	03	40	60	100	3
6	PCC	18MEL76	Computer Integrated Manufacturing Lab		--	2	2	03	40	60	100	2
	PCC	18MEL77	Design Lab		--	2	2	03	40	60	100	2
7	Project	18MEP78	Project Work Phase - 1		--	--	2	--	100	--	100	1
8	Internship	--	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	**15**	**04**	**06**	**18**	**340**	**360**	**700**	**20**

Professional Elective - 2

Course code under 18XX73X	Course Title	Course code under 18XX73X	Course Title
18ME731	**Design for Manufacture**	18ME734	**Total Quality Management**
18ME732	**Automation and Robotics**	18ME735	**Operations Research**
18ME733	**Computational Fluid Dynamics**		

Professional Electives - 3

Course code under 18XX74X	Course Title	Course code under 18XX74X	Course Title
18ME741	**Additive Manufacturing**	18ME744	**Mechatronics**
18ME742	**Emerging Sustainable Building Cooling Technologies**	18ME745	**Project Management**
18ME743	**Theory of Plasticity**		

Open Elective -B

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX75X).

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Project work:

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or6.

CIE procedure for Project Work Phase - 1:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Internship: All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the Internship requirements.

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

CONTROL ENGINEERING

Course Code	**18ME71**	CIE Marks	40
Teaching Hours / Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To develop comprehensive knowledge and understanding of modern control theory, industrial automation, and systems analysis.
- To model mechanical, hydraulic, pneumatic and electrical systems.
- To represent system elements by blocks and its reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyse a system using root locus plots.
- To study different system compensators and characteristics of linear systems.

Module-1

Introduction: Components of a control system, Open loop and closed loop systems.
Types of controllers: Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral-Differential controllers.
Modelling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems.

Module-2

Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady state error, error constants.

Module-3

Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.

Module-4

Stability of linear control systems: Routh's criterion, Root locus, Determination of phase margin and gain margin using root locus.

Module-5

Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot.

Assignment:
1.Study of On-Off Controller for Flow/ Temperature.
2. Study of Control Modes like P, PD, PI, PID for Pressure / Temperature / Flow.
3. Assignment on Root Locus, Bode Plots and Polar Plots.
4. Use of Software 'MATLAB' on the above topics.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Identify the type of control and control actions.
CO2: Develop the mathematical model of the physical systems.
CO3: Estimate the response and error in response of first and second order systems subjected standard input signals.
CO4: Represent the complex physical system using block diagram and signal flow graph and obtain transfer function.
CO5: Analyse a linear feedback control system for stability using Hurwitz criterion, Routh's criterion and root Locus technique in complex domain.

CO6: Analyse the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automatic Control Systems	Farid G., Kuo B. C	McGraw Hill Education	10th Edition,2018
2	Control systems	Manik D. N	Cengage	2017
Reference Books				
1	Modern control Engineering	K. Ogeta	Pearson	5th Edition, 2010
2	Control Systems Engineering	Norman S Nice		Fourth Edition, 2007
3	Modern control Systems	Richard C Dorf	Pearson	2017
4	Control Systems Engineering	IjNagrath, M Gopal	New Age International (P) Ltd	2018
5	Control Systems Engineering	S Palani	Tata McGraw Hill Publishing Co Ltd	ISBN-13 978007067193

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

COMPUTER AIDED DESIGN AND MANUFACTURING

Course Code	**18ME72**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
- To make students to understand the Computer Applications in Design and Manufacturing [CAD / CAM) leading to Computer integrated systems. Enable them to perform various transformations of entities on display devices.
- To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
- To expose students to computer aided process planning, material requirement planning, capacity planning etc.
- To expose the students to CNC Machine Tools, CNC part programming, and industrial robots.
- To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

Module-1

Introduction to CIM and Automation: Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems.

Automated Production Lines and Assembly Systems: Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer, fundamentals of automated assembly systems, numericals.

Module-2

CAD and Computer Graphics Software: The design process, applications of computers in design**,** software configuration, functions of graphics package, constructing the geometry.

Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations.

Computerized Manufacture Planning and Control System: Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control

Module-3

Flexible Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.

Line Balancing: Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method, Mixed Model line

balancing, computerized line balancing methods.

Module-4

Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations.

Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and off-line methods. Robot industrial applications: material handling, processing and assembly and inspection.

Module-5

Additive Manufacturing Systems: Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM.

Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen

CO2: Explain the basics of automated manufacturing industries through mathematical models and analyze different types of automated flow lines.

CO3: Analyse the automated flow linestoreduce time and enhance productivity.

CO4: Explain the use of different computer applications in manufacturing, and able to prepare part programs forsimple jobs on CNC machine tools and robot programming.

CO5: Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automation, Production Systems and Computer-Integrated Manufacturing	Mikell P Groover	Pearson Learning.	4th Edition,2015
2	CAD / CAM Principles and Applications	P N Rao	Tata McGraw-Hill	3rd Edition, 2015
3	CAD/CAM/CIM	Dr. P. Radhakrishnan	New Age International Publishers, New Delhi.	3rd edition
Reference Books				
1	"CAD/CAM"	Ibrahim Zeid	Tata McGraw Hill.	
2	Principles of Computer Integrated Manufacturing	S.Kant Vajpayee	, Prentice Hall of India, New Delhi.	1999

3	Work Systems And The Methods, Measurement And Management of Work	Groover M. P.,Pearson	Prentice Hall	Upper Saddle River, NJ, 2007.
4	Computer Automation in Manufacturing	Boucher, T. O., Chapman & Hall	London, UK,	1996.
5	Introduction to Robotics: Mechanics And Control	Craig, J. J.	Addison-Wesley Publishing Company	2nd Ed 1989.
6	Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition	Nicolas Windpassinger	Amazon.	
7	Internet of Things: A Hands-on Approach"	ArshdeepBahga and Vijay Madisetti	Universities Press	
8	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing,	Ian Gibson, David W. Rosen, Brent Stucker		2nd Ed. (2015)
9	Understanding Additive Manufacturing	Andreas Gebhardt, Hanser Publishers		2011
10	Understanding Additive Manufacturing",	Andreas Gebhardt,	Hanser Publishers,	2011

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 2

DESIGN FOR MANUFACTURE

Course Code	**18ME731**	CIE Marks	40
Teaching Hours / Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To educate students on factors to be considered in designing parts and components with focus on manufacturability.
- To expose the students to dimensional tolerances, geometric tolerances and true position tolerance techniques in manufacture.
- To impart the knowledge on design considerations for designing components produced using various machining operations like turning, drilling, milling, grinding etc.
- To educate the students on design rules and recommendations for processes like casting, welding, forgings powder metallurgy and injection moulding.

Module-1

Introduction: Definition, need for DFM, DFM approach for cost reduction, general design guide lines of DFM, advantages and disadvantages, application of DFM in industries, Design for Quality Manufacturability, DFQM approach, designing for economical production. Design for Excellence (DFX).

Engineering Tolerancing: Basics of dimensional tolerancing, Redundancy, tolerance allocation, Review of relationship between attainable tolerance grades and different machining processes. Geometrical tolerances. Process capability, mean, variance, skewness, kurtosis, process capability indices- C_p, and C_{pk}. Cumulative effect of tolerance- Sure fit law and truncated normal law, problems.

Module-2

True positional theory: Comparison between coordinate and true position method of feature location. True position tolerance- virtual size concept, concepts of datum and changing datum, floating and fixed fasteners, projected tolerance zone and functional gages. Concept of Zero true position tolerance. Simple problems on true position tolerancing.

Selective Assembly: Interchangeable part manufacture and selective assembly. Deciding the number of groups -model-1: group tolerance of mating parts equal, model- 2: total and group tolerances of shaft equal. Control of axial play- introducing secondary machining operations, and laminated shims; examples.

Module-3

Datum Features: Functional datum, datum for manufacturing, changing the datum; examples.

Component Design: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility. Designing for heat treatment, roller burnishing, and economical de-burring.

Module-4

Design of components with casting considerations: Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Castings requiring special sand cores. Designing to obviate sand cores.

Welding considerations: Advantages of weldments over other design concepts, design requirements and rules, redesign of components for welding; case studies.

Module-5

Forging considerations -requirements and rules-redesign of components for forging and case studies.
Design of components for powder metallurgy- requirements and rules-case studies.
Design of components for injection moulding- requirements and rules-case studies.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.
CO2: Identify faulty design factors leading to increased costs in producing mechanical components.
CO3: Apply appropriate design tolerances – dimensional, geometric and true position tolerances for the production processes of mechanical components.
CO4: Apply the concepts related to reducing machined areas, simplification by amalgamation and separation, clampability, accessibility etc., in the design of mechanical components.
CO5: Analyse the design of castings, weldments, forgings, powder metallurgy components and suggest design modifications to reduce the cost.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Designing for Manufacture	Peck H	Pitman Publications	1983
2	Engineering Design: A Materials and processing Approach	Dieter, G.E.	McGraw Hill Co.Ltd	2000
3	Handbook of Products Design for Manufacturing: A Practical Guide to Low-cost Production	Bralla, James G.	McGraw Hill, New York	1986
Reference Books				
1	Engineering Design	Eggert, R.J	Pearson Education, Inc., New Jersey	2005
2	Engineering Design	Matousek , R	Blackie and Son Limited, Glasgow	1967
3	Engineering Design for Manufacture	Kalandar Saheb, S.D and Prabhakar, O.	ISPE	1999
4	Design for Economical Production	Trucks, H.E.	Mich., Dearborn, SME	2nd ed.,1987
5	Processes and Materials of Manufacture	Linberg, Roy A.	Allyn and Bacon, Boston, U.S.A.	4th ed., 1990

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 2

AUTOMATION & ROBOTICS

Course Code	**18ME732**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:2:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To identify potential areas for automation and justify need for automation.
- To select suitable major control components required to automate a process or an activity
- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study the control of robots for some specific applications.

Module-1:

Introduction to automation:
Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data

Module-2:

Automated production lines:
Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems, automatic identification methods, barcode technology, radio frequency identification, other AIDC technologies

Module-3: Industrial Robotics

Robotic configuration, robot anatomy and related attributes, robot control systems, end effectors, sensors in robotics, industrial robot applications, robot accuracy and repeatability, different types of robots, various generations of robots, degrees of freedom – Asimov's laws of robotics, dynamic stabilization of robots.

Module-4: Spatial descriptions and transformations

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison. Position sensors –potentiometers, resolvers, encoders –Velocity sensors, Tactile sensors, Proximity sensors. Manipulator Kinematics: Homogeneous transformations as applicable to rotation and translation -D-H notation, Forward and inverse kinematics.

Module-5: Robot programming

Introduction, levels of robot programming, requirements of robot programming language, problems pertaining to robot programming languages, offline programming systems, central issues in OLP systems, automating subtasks in OLP systems, simple programs on robot applications.

Course Outcomes: At the end of the course, the student will be able to:
CO1: Translate and simulate a real time activity using modern tools and discuss the Benefits of automation.
CO2: Identify suitable automation hardware for the given application.
CO3: Recommend appropriate modelling and simulation tool for the given manufacturing Application.
CO4: Explain the basic principles of Robotic technology, configurations, control and Programming of Robots.
CO5: Explain the basic principles of programming and apply it for typical Pick & place, Loading & unloading and palletizing applications

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.

- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Computer Integrated Manufacturing	Mikell P. Groover	Pearson	3rd edition, 2009
2	Introduction to robotics mechanics and control	John J. Craig	Pearson	3rd edition, 2009
Reference Books				
1	Robotics for Engineers	Yoram Koren	McGraw Hill International	1st edition, 1985.
2	Industrial Robotics	Weiss, Nagel	McGraw Hill International	2nd edition, 2012
3	Robotic Engineering - An Integrated approach	Klafter, Chmielewski and Negin	PHI	1st edition, 2009
4	Computer Based Industrial Control	Krishna Kant	EEE-PHI	2nd edition,2010
5	An Introduction to Automated Process Planning System	Tiess Chiu Chang & Richard A. Wysk.		

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 2

COMPUTATIONAL FLUID DYNAMICS

Course Code	**18ME733**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Study the governing equations of fluid dynamics
- Learn how to formulate and solve Euler's equation of motion.
- Become skilled at Representation of Functions on Computer
- Solve computational problems related to fluid flows

Module-1

Introduction to CFD and Governing Equations

Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and curl operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). Mathematical classification of PDE (Hyperbolic, Parabolic, Elliptic). Method of characteristics, Introduction to Riemann Problem and Solution Techniques.

Module-2

One-dimensional Euler's equation

Conservative, Non-conservative form and primitive variable forms of Governing equations. Flux Jacobian Is there a systematic way to diagona lize '**A**'. Eigen values and Eigenvectors of Flux Jacobian. Decoupling of Governing equations, introduction of characteristic variables. Relation between the two non-conservative forms. Conditions for genuinely nonlinear characteristics of the flux Jacobian.

Introduction to Turbulence Modelling: Derivation of RANS equations and k-epsilon model.

Module-3

Representation of Functions on Computer

Need for representation of functions, Box Function, Hat Function, and Representation of sinx using hat functions: Aliasing, high frequency, low frequency. Representation error as a global error. Derivatives of hat functions, Haar functions, Machine Epsilon. Using Taylor series for representation of Derivatives.

Module-4

Finite difference method – Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burgers equations, modified equations. Explicit methods and Implicit methods – as applied to applied to linear convection equation, Laplace equations, convection-diffusion equation◦ FTCS,FTFS,FTBS,CTCS ◦ Jacobi Method, Gauss-Siedel, Successive Over Relaxation Method, TDMA• Von Naumann stability (linear stability) analysis. Upwind Method in Finite Difference method.

Module-5

Finite volume method Finite volume method. Finding the flux at interface.

Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and Mac Cormack Method

Upwind Method in Finite Volume methods - Flux Splitting Method Steger and Warming, vanLeer, Roe's Method and finding Roe's Averages.

Course Outcomes:

At the end of the course the student will be able to:

CO1: Understand mathematical characteristics of partial differential

equations.

CO2: Explain how to classify and computationally solve Euler and Navier-Stokes equations.

CO3: Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.

CO4: Identify and implement numerical techniques for space and time integration of partial differential equations.

CO5: Conduct numerical experiments and carry out data analysis.

CO6: Acquire basic skills on programming of numerical methods used to solve the Governing equations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Computational Fluid Dynamics	T.j.chung	Cambridge University Press	
2	Computational fluid dynamics and heat transfer	Ghoshdastidar	Cengage learning	2017
3	Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics – Vol 1 & Vol 2	Charles Hirsch	Butterworth- Heinemann	2007
4	Numerical Heat Transfer and Fluid Flow	SuhasPatankar	Taylor and Francis Publisher	
5	Introduction Computational Fluid Dynamics -Development, Application and Analysis	Atul Sharma	Wiely Publisher	
Reference Books				
1	Computational fluid mechanics and heat transfer	Pletcher, r. H., Tannehill, j. C., Anderson, d.	Crc press, ISBN 9781591690375	3rd ed, 2011
2	Fundamentals of engineering numerical analysis	Moin, p	Cambridge university press, , ISBN 9780521805261	2nd ed, 2010
3	Numerical methods for engineering application	Ferziger, j. H	Wiley	2nd ed, 1998
4	Computational methods for fluid dynamics	Ferziger, j. H., Peric, m	Springer	3rd ed
5	Numerical methods for conservation laws	eth Zurich, birkhauser		pp-199
6	Practical Introduction	Eleuterio F Toro	Springer	

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 2

TOTAL QUALITY MANAGEMENT

Course Code	**18ME734**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Understand various approaches to TQM
- Understand the characteristics of quality leader and his role.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge in Tools and Techniques of quality management.

Module-1

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.

Module-2

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,

Module-3

Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

Module-4

Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

Module-5

Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance.
Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD.
Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS.

Course Outcomes: At the end of the course, the student will be able to:
CO1: Explain the various approaches of TQM
CO2: Infer the customer perception of quality
CO3: Analyse customer needs and perceptions to design feedback systems.
CO4: Apply statistical tools for continuous improvement of systems
CO5: Apply the tools and technique for effective implementation of TQM.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Total Quality Management	Dale H. Besterfield	Pearson Education India,	Edition 03. ISBN: 8129702606,
2	Total Quality Management for Engineers	M. Zairi	Wood head Publishing	ISBN:1855730243
Reference Books				
1	Managing for Quality and Performance Excellence	James R. Evans and William M Lindsay	Cengage Learning.	9th edition
2	Four revolutions in management	Shoji Shiba, Alan Graham, David Walden	Oregon	1990
3	Organizational Excellence through TQM	H. Lal	New age Publications	2008
4	Engineering Optimization Methods and Applications	A Ravindran, K, M. Ragsdell	Willey India Private Limited	2nd Edition,2006
5	Introduction to Operations Research- Concepts and Cases	F.S. Hillier. G.J. Lieberman	Tata McGraw Hill	9th Edition, 2010

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 2

OPERATIONS RESEARCH

Course Code	**18ME735**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.
- To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials and machinery.

Module-1

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).

Module-2

LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and two-phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

Module-3

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem. Assignment Problem-Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems.

Module-4

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems. Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.

Module-5

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games. Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of2 jobs on 'm' machines using graphical method.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the meaning, definitions, scope, need, phases and techniques of operations research.

CO2: Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.

CO3: Formulate as Transportation and Assignment problems and derive optimum solutions for transportation,

Assignment and travelling salesman problems.

CO4: Solve problems on game theory for pure and mixed strategy under competitive environment.

CO5: Solve waiting line problems for M/M/1 and M/M/K queuing models.

CO6: Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks

CO7: Determine minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Operations Research	P K Gupta and D S Hira	S. Chand and Company LTD. Publications, New Delhi	2007
2	Operations Research, An Introduction	Hamdy A. Taha	PHI Private Limited	Seventh Edition, 2006
Reference Books				
1	Operations Research, Theory and Applications	J K Sharma	Trinity Press, Laxmi Publications Pvt.Ltd.	Sixth Edition, 2016
2	Operations Research	Paneerselvan	PHI	
3	Operations Research	A M Natarajan, P Balasubramani	Pearson Education,	2005
4	Introduction to Operations Research	Hillier and Lieberman	McGraw Hill	8thEd

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 3

ADDITIVE MANUFACTURING

Course Code	**18ME741**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
- To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies and Direct Digital Manufacturing.
- To get exposed to process selection, software issues and post processing.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereoli tho graphy or 3dprinting, rapid proto typing ,the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.
Development of Additive Manufacturing Technology: Introduction, computers, computer-aidedde sign technology ,other associated technologies, the use of layers, classification of AM processes, metals ystems, hybrid systems, milestones in AM development.
Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another ,metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.

Module-2

Photo polymerization processes: Stereolitho graphy (SL), Materials, SL resin curing process, Micro-stereoli thography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.
Powder bedfusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.
Extrusion-based systems: Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

Module-3

Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modeling, material modification methods, three-dimensional printing, advantages of binder printing
Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.
Beam Deposition Processes: introduction, general beam deposition process, description material delivery, BD systems , process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks.
Direct Write Technologies: Background ,ink -basedDW,laser transfer, DW thermals pray,DW beam deposition,DW liquid-phase directde position.

Module-4

Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control.
Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation.
Post- Processing: Support material removal**,** surface texture improvements**,** preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques**.**

Module-5

The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions.
AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application: Examples for Aerospace, defense, automobile, Bio-medical and general engineering industries.
Direct digital manufacturing: Align Technology, siemens and phonak, DDM drivers, manufacturing vs. prototyping, life- cycle costing, future of direct digital manufacturing.

Course Outcomes: At the end of the course the student will be able to:

CO1: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
CO2: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
CO3: Understand the various software tools, processes and techniques that enable advanced/additive manufacturing.
CO4: Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.
CO6: Understand characterization techniques in additive manufacturing.
CO7: Understand the latest trends and business opportunities in additive manufacturing.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing	I. Gibson l D. W. Rosen l B. Stucker	Springer New York Heidelberg Dordrecht, London	ISBN: 978-1-4419-1119-3 e-ISBN: 978-1-4419-1120-9 DOI 10.1007/978-1-4419-1120-9
Reference Books				
1	“Rapid Prototyping: Principles & Applications	Chua Chee Kai, Leong Kah Fai	World Scientific	2003
2	Rapid Prototyping: Theory & Practice	Ali K. Kamrani,	Springer	2006

		EmandAbouel Nasr,		
3	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling"	D.T. Pham, S.S. Dimov	Springer	2001
4	Rapid Prototyping: Principles and Applications in Manufacturing	RafiqNooran	John Wiley & Sons	2006
5	Additive Manufacturing Technology	Hari Prasad, A.V.Suresh	Cengage	2019
6	Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing	Andreas Gebhardt	Hanser Publishers	2011

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 3

EMERGING SUSTAINABLE BUILDING COOLING TECHNOLOGIES

Course Code	**18ME742**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To provide an overview of emerging delivery systems for high performance green buildings and the basis on which their sustainability can be evaluated
- To know the concepts of calculations of heating and cooling loads and the related economics.
- To learn the importance of green fuels and its impact on environment.
- To expose the students to sustainable cooling technologies.

Module-1

Social and Environmental Issues related to conventional Refrigeration and Air conditioning: Climate Change and energy poverty implications of energy consumption and refrigerants use by conventional Vapor-Compression based RAC technologies, Global and Indian environmental, energy efficiency and green building policies, laws and rules warranting a trajectory shift in the RAC economy, Introduction to Thermal comfort as an 'ends' and cooling systems as a 'means', Socio-economic and environmental benefits of a Negawatt approach to energy conservation vs. a Megawatt approach towards power generation.

Module-2

Thermal Comfort, Climate Analysis and Psychrometry: The 'human thermal comfort' lens and its implications for cooling system design, Progressive models for addressing human thermal comfort needs, Thermodynamics of human body, Factors affecting human comfort, Introduction to the ASHRAE Std. 55, Adaptive Comfort Model and the Indian Model for Adaptive Comfort (IMAC) and its implications for mitigating climate change and energy consumption from cooling technologies, Tools for predicting thermal comfort in buildings, Principles and tools for climate analysis, Composition of Psychrometric Charts, Psychrometric processes of conventional and sustainable cooling technologies and representation on psychrometric chart, Application of psychrometry to design conventional and sustainable cooling technologies.

Indoor Air Quality and Building Cooling Load Modelling:

Addressing trade-offs between indoor air quality requirements, daylighting needs, and solar heat gain reduction in artificially cooled buildings. Factors affecting building cooling loads. Building cooling load

Module-3

Refrigeration Systems and Refrigerants:

Thermodynamics of Vapor Compression Refrigeration (VCR) and Vapor Absorption Machine (VAM) Cycles, Equipment used in commercial and residential VCR and VAM systems, Physical, Chemical, Thermodynamic and Environmental properties of Refrigerants and Refrigerant mixtures **(**zeotropic and azeotropic mixtures) used in conventional VCR system, Absorbent **–** Refrigerant combinations (Water-Ammonia and Lithium-Bromide) used in VAM systems, Physical, Chemical, Thermodynamic and Environmental properties of emerging Natural Refrigerants for VCR systems.

Module-4

Air conditioning:

Air conditioning demand scenarios for India and associated health, social justice, energy access, and environmental Implications for its peoples and communities, Potential sustainable air conditioning scenarios for India, Heat transfer and psychrometric principles of air conditioning cycles, Engineering principles of air conditioning components, Air conditioning coefficient-of-performance calculation, Energy efficient air conditioning system, Energy and greenhouse gas emissions-based performance comparison of natural

refrigerant and f-gas based air conditioners.

Module-5

Sustainable Cooling Technologies:

Radical social justice fostering, energy conservation, and climate change mitigation potential of natural cooling, Design principles of natural and sustainable cooling systems, Science and engineering design principles of a) Direct, Indirect, and Hybrid (Direct-Indirect and DX) Evaporative Cooling technology, b) Structure Cooling, c) Radiant Cooling Systems, and d) Solar VAM technology, Basic equipment sizing calculations, System performance assessment methods, Comparative energy consumption, greenhouse gas emissions and life-cycle cost case studies for residential and commercial applications of conventional and sustainable cooling technologies.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Empathize with sustainable cooling as a means of enhancing social justice in India and mitigating climate change through their intellectual capabilities and ethical orientation

CO2: Compute and Interpret cooling and heating loads in a building and how they could be efficiently managed by using building energy modelling software

CO3: Estimate the performance of airconditioning systems using the principles of thermodynamics, heat transfer, and psychometry

CO4: Calculate and interpret the energy, cost, and greenhouse gas emissions performance of conventional and sustainable cooling technologies.

Co6: Conduct building and sustainable cooling modelling projects on a sophisticated building energy modelling software.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Refrigeration and Airconditioning	C P Arora	Tata McGraw Hill	3rd Edition
2	Heating, Ventilating and Airconditioning	Faye C McQuiston, Jerald D. Parker, Jeffrey D. Spitler	Wiley Indian Private Ltd.	
Reference Books				
1	Radiant Heating and Cooling Handbook	Richard D. Watson	McGraw-Hill Publication	2002
Link: https://www.accessengineeringlibrary.com/browse/radiant-heating-and-cooling-handbook#p2000a97e9970iii001				
2	Evaporative Cooling		CAREL	
Link: http://www.carel.com/-evaporative-cooling-book				

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 3

THEORYOF PLASTICITY

Course Code	**18ME743**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To introduce the concepts of Plasticity and mechanism of plastic deformation in metals.
- To expose the students to elasto-plastic problems involving plastic deformation of beams and bars.
- To introduce the concepts of slip line field theory.

Module-1

Brief review of fundamentals of elasticity: Concept of stress, stress invariants, principal Stresses, octahedral normal and shear stresses, spherical and deviatoric stress, stress transformation; concept of strain, engineering and natural strains, octahedral strain, deviator and spherical strain tensors, strain rate and strain rate tensor, cubical dilation, generalized Hooke's law, numerical problems.

Module-2

Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, re crystallization and grain growth, flow figures or Luder's cubes.

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criterion, geometrical representation, yield surface, yield locus (two-dimensional stress space), experimental evidence for yield

Module-3

Stress Strain Relations: Idealised stress-strain diagrams for different material models, empirical equations, Levy-Von Mises equation, Prandtl -Reuss and Saint Venant theory, experimental verification of Saint Venant's theory of plastic flow. Concept of plastic potential, maximum work hypothesis, mechanical work for deforming a plastic substance.

Module-4

Bending of Beams: Stages of plastic yielding, analysis of stresses, linear and nonlinear stress strain curve, problems.

Torsion of Bars: Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, problems.

Module-5

Slip Line Field Theory: Introduction, basic equations for incompressible two-dimensional flows, continuity equations, stresses in conditions of plain strain, convention for slip lines, geometry of slip line field, properties of the slip lines, construction of slip line nets.

Course Outcomes: At the end of the course the student will be able to:

CO1: Understand stress, strain, deformations, relation between stress and strain and plastic deformation in solids.

CO2: Understand plastic stress-strain relations and associated flow rules.

CO3: Perform stress analysis in beams and bars including Material nonlinearity.

CO4: Analyze the yielding of a material according to different yield theory for a given state of stress.

CO5: Interpret the importance of plastic deformation of metals in engineering problems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Theory of Plasticity	Chakraborty	Elsevier	3rd Edition
2	Theory of Plasticity and Metal forming Process	Sadhu Singh	Khanna Publishers, Delhi	
Reference Books				
1	Engineering Plasticity-Theory and Application to Metal Forming Process	R.A.C. Slater	McMillan Press Ltd.	
2	Basic Engineering Plasticity	DWA Rees	Elsevier	1st Edition
3	Engineering Plasticity	W. Johnson and P. B. Mellor	Van NoStrand Co. Ltd	2000
4	Advanced Mechanics of solids	L. S. Srinath	Tata Mc. Graw Hill	2009

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 3

MECHATRONICS

Course Code	**18ME744**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
- To understand the evolution and development of Mechatronics as a discipline.
- To substantiate the need for interdisciplinary study in technology education
- To understand the applications of microprocessors in various systems and to know the functions of each element.
- To demonstrate the integration philosophy in view of Mechatronics technology
- To be able to work efficiently in multidisciplinary teams.

Module-1

Introduction: Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.
Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.

Module-2

Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.
Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.

Module-3

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.
Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

Module-4

Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.
Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

Module-5

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Machine Elements: Different types of guide ways, Linear Motion guideways. Bearings: anti-friction bearings,

hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.

Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.

Course Outcomes: At the end of the course the student will be able to:

CO1: Illustrate various components of Mechatronics systems.

CO2: Assess various control systems used in automation.

CO3: Design and conduct experiments to evaluate the performance of a mechatronics system or component with

respect to specifications, as well as to analyse and interpret data.

CO4: Apply the principles of Mechatronics design to product design.

CO5: Function effectively as members of multidisciplinary teams.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Mechatronics-Principles Concepts and Applications	Nitaigour Premchand Mahalik	Tata McGraw Hill	1st Edition, 2003
2	Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering,	W.Bolton	Pearson Education	1stEdition, 2005
Reference Books				
1	Mechatronics	HMT Ltd	Tata Mc Graw Hill	1st Edition, 2000 ISBN:978007 4636435
2	Mechatronics: Integrated Mechanical Electronic Systems	K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram.	Wiley India Pvt. Ltd. New Delhi	2008
3	Introduction to Mechatronics and Measurement Systems	David G. Aldatore, Michael B. Histand	McGraw-Hill Inc USA	2003
4	Introduction to Robotics: Analysis, Systems, Applications.	Saeed B. Niku,	Person Education	2006
5	Mechatronics System Design	Devdas Shetty, Richard A. kolk	Cengage publishers.	second edition

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
Professional Elective 3

PROJECT MANAGEMENT

Course Code	**18ME745**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To understand how to break down a complex project into manageable segments and use of effective project management tools and techniques to arrive at solution and ensure that the project meets its deliverables and is completed within budget and on schedule.
- To impart knowledge on various components, phases, and attributes of a project.
- To prepare students to plan, develop, lead, manage, and successfully implement and deliver projects within their chosen practice area.

Module-1

Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.

Module-2

Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system. Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.

Module-3

Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kick off project, baseline and communicate project management plan, using Microsoft Project for project baselines.

Module-4

Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. 28 Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.

Module-5

Network Analysis: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERTfor finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.

Course Outcomes: At the end of the course the student will be able to:

CO1: Understand the selection, prioritization and initiation of individual projects and strategic role of project management.

CO2: Understand the work breakdown structure by integrating it with organization.

CO3: Understand the scheduling and uncertainty in projects.

CO4: Understand risk management planning using project quality tools.
CO5: Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.
CO6: Determine project progress and results through balanced scorecard approach
CO7: Draw the network diagram to calculate the duration of the project and reduce it using crashing.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Project Management	Timothy J Kloppenborg	Cengage Learning	Edition 2009
2	Project Management -A systems approach to planning scheduling and controlling	Harold kerzner	CBS publication	
3	Project Management	S Choudhury	McGraw Hill Education (India) Pvt. Ltd. New Delhi	2016
Reference Books				
1	Project Management	Pennington Lawrence	Mc Graw Hill	
2	Project Management	A Moder Joseph and Phillips New Yark	Van Nostrand Reinhold	
3	Project Management,	Bhavesh M. Patal	Vikas publishing House	

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

Open Elective-B (Semester VII)

ENERGY AND ENVIRONMENT

Course Code	**18ME751**	CIE Marks	40
Teaching Hours / Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies.
- To introduce various aspects of environmental pollution and its control.
- To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.
- To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.

Module-1

Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.

Module-2

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems
Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing
Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries

Module-3

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness.
Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

Module-4

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies.

Module-5

Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.

Group assignments:
Assignments related to e-waste management; Municipal solid waste management; Air pollution control systems; Water treatment systems; Wastewater treatment plants; Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Biofuels; Environmental status assessments; Energy status assessments etc.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand energy scenario, energy sources and their utilization.
CO2: Understand various methods of energy storage, energy management and economic analysis.
CO3: Analyse the awareness about environment and eco system.
CO4: Understand the environment pollution along with social issues and acts.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education		University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune	
2	Energy Management Audit & Conservation- for Module 2	Barun Kumar De	Vrinda Publication	2nd Edition 2010
Reference Books				
1	Energy Management Hand book	Turner, W. C., Doty, S. and Truner, W. C	Fairmont Press	7th Edition 2009
2	Energy Management	Murphy, W. R	Elsevier	2007
3	Energy Management Principles	Smith, C. B	Pergamum	2007
4	Environment pollution control Engineering	C S Rao	New Age International	reprint 2015, 2nd edition
5	Environmental studies	Benny Joseph	Tata McGraw Hill	2nd edition 2008

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

Semester VIII Open Elective B

AUTOMOTIVE ENGINEERING

Course Code	**18ME752**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To know layout and arrangement of principal parts of an automobile.
- To understand the working of transmission and brake systems.
- To comprehend operation and working of steering and suspension systems.
- To know the Injection system and its advancements.
- To know the automobile emissions and its effects on environment.

Module-1

ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I.Engine and C.I.Engines, methods of a Swirl generation, engine positioning. Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car.

COOLING AND LUBRICATION: Cooling requirements, Types of cooling- Thermo siphon system, Forced circulation water cooling system, Water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

Module-2

TRANSMISSION SYSTEMS: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

BRAKES: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock – Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock, & Numerical.

Module-3

STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

Module-4

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.

FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, Alternative fuels, Normal and Abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburetors, C.D.& C.C. carburettors, Multi point and Single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System.

Module-5

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.
EMISSION STANDARDS: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act.

Course Outcomes: At the end of the course, the student will be able to:

- Identify the different parts of an automobile and it's working.
- Understand the working of transmission and braking systems.
- Understand the working of steering and suspension systems and their applications.
- Selection and applications of various types of fuels and injection systems.
  Analyse the cause of automobile emissions, its effects on environment and methods to reduce the emissions.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automobile engineering Vol I and II	Kirpal Singh	Standard Publishers	12th Edition 2011
2	Automotive Mechanics	S. Srinivasan	Tata McGraw Hill	2003 2nd Edition
Reference Books				
1	Automotive Mechanics	William H Crouse & Donald L Anglin	Tata McGraw Hill Publishing Company	10th Edition 2007
2	Automotive Mechanics: Principles and Practices,	Joseph Heitner	D Van Nostrand Company, Inc	
3	Automobile Engineering	R. B. Gupta	Satya Prakashan	4thedition 1984.
4	Fundamentals of Automobile Engineering	K.K.Ramalingam	Scitech Publications (India) Pvt. Ltd	

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

Semester VII Open Elective-B

INDUSTRIAL SAFETY

Course Code	**18ME753**	CIE Marks	40
Teaching Hours / Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- The present course highlights the importance of general safety and its prevention.
- It enables students to understand about mechanical, electrical sand chemical safety.
- The Industrial safety course helps in motivating the students to understand the reason for fire
- Its Controlling of fire by various means are highlighted.
- Importance of chemical safety, labelling of chemicals, hand signals during forklift operations in industrial and aerodromes will help in to understand and apply the techniques in practical field.
- A visit to campus, various labs, workshops, local industries and fire stations helps in analyzing the importance of safety and corrective measures through case studies.

Module-1

Terms used: accident, safety, hazard, safe, safety devices, safety guard, security, precaution, caution, appliance, slip, trip, fall. Ladders and scaffolding. Unsafe acts, reason for accidents, MSDS (material safety data sheet), computer Aided Hazard Analysis, International acts and standards OSHA, WHO. Environment act, control and abatement of environmental pollution-Biomedical waste. Lockout and tag out procedures. Safe material handling and storage. Risk analysis quantification.

Case studies: Student should identify the unsafe acts near their surroundings like housekeeping, lab as well as industrial layouts, road safety, campus layout, safety signs.

Module-2

Introduction, toxicity of products of combustion – vapour clouds – flash fire – jet fires – pool fires – auto-ignition, sources of ignition . Class A, B, C, D and E fire. Fire triangle, Fire extinguishers, Fire hazard and analysis, prevention of fire. Fire protection and loss prevention, steps after occurrence of fire. notice-first aid for burns, Portable fire extinguishers. Fire detection, fire alarm and firefighting systems. Safety sign boards, instruction on portable fire extinguishers. Case studies: demonstration of fire extinguishers, visit to local fire fighting stations. Visit to fire accident sites to analyze the cause of fire and its prevention for future.

Module-3

PPE, safety guards, Mechanical hazards, workplace hazards, Forklift hazard control Safety while working with machine tools like lathe, drill press, power and band saws, grinding machines. Safety during welding, forging and pressing. Safety while handling Material, compressed gas cylinders, corrosive substance, waste drum and containers.

Case studies: Visit to machine shop, workshops, foundry lab and local industries to record the practical observation and report the same with relevant figures and comments.

Module-4

Introduction to electrical safety, Indian standards on electrical safety, Electric hazards, effect of electric current on human body, causes of electrical accidents, prevention of electric accidents, PPE used. Protection systems: Fuse, circuit breakers and overload relays – protection against over voltage and under voltage. Electric shock. Primary and secondary electric shocks, AC and DC current shocks. Safety precautions against shocks. Safety precautions in small and residential building installations. Safety procedures in electric plant.

Case studies: To visit electrical sub stations, local distribution systems, observe and share the experience and report.

Module-5

Introduction to Chemical safety, Labelling of chemicals, acid hoods. Handling of acids, eye washers and showers. Safety thinking, accident investigation, safety policy of the company, safety, loss prevention and control, check list for LPG installations, safety precautions using CNG, fire prevention and safety audit, confined space entry, risk assessment.

Case studies: To visit chemical laboratory of the college and other chemical industries like LPG , CNG facilities and report.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the basic safety terms and international standards.

CO2: Identify the hazards and risk analysis around the work environment and industries.

CO3: Use the safe measures while performing work in and around the work area of the available laboratories. Able to recognize the sign boards and its application

CO4: Recognise the types of fires extinguishers and to demonstrate the portable extinguishers used for different classes of fires.

CO5: Report the case studies by sharing experience of the employees working in housekeeping, laboratories like workshops, electrical labs, machine shops, electronics and computer laboratories.

CO6: Recognise the chemical and electrical hazards for its prevention and control.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Industrial Safety and Management	L M Deshmukh	McGraw Hill Education (India) private Limited	ISBN-13: 978-0-07-061768-1
2	Fire Prevention Hand Book	Derek, James	Butter Worth's and Company, London	1986
3	Electrical Safety, fire safety and safety management	S.Rao, R K Jain and Saluja	Khanna Publishers	ISBN: 978-81-7409-306-6
4	Industrial health and safety management	A.M.Sarma	Himalya publishing house	
5	Chemical process Industrial safety	K S N Raju	McGraw Hill Education (India) private Limited.	ISBN-13: 978-93-329-0278-7
6	Environmental engineering	Gerard Kiely	McGraw Hill Education (India) private Limited	ISBN-13: 978-0-07-063429-9
Reference Books				
1	The Environment Act (Protection) 1986	Commercial Law Publishers (India) Pvt. Ltd. New Delhi.		
2	Water (Prevention and control of pollution) act 1974	Commercial Law publishers (India)		

		Pvt. Ltd., New Delhi.		
• To visit respective Institution: stores, office, housekeeping area, laboratories. • To visit local industries, workshops, district firefighting system facility and local electrical power stations.				

OPEN ELECTIVE B

B. E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER – VII

OPTIMISATION TECHNIQUES

Course Code	**18ME754**	CIE Marks	40
Teaching Hours / Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To expose the students to techniques to optimize complex engineering problems.
- To introduce non-linear programming techniques.
- To introduce the Integer programming method.

Module-1

Introduction: Statement of optimisation problem, Design vector, Design constraints, Objective function, Classification of optimisation problems based on :constraints, nature of design variables, nature of the equations involved

Single variable optimisation: Necessary and sufficient conditions, Multivariable optimization with no constraints: Necessary and sufficient conditions, Semi definite case, Saddle point, Multi variable optimization with equality constraints, Solution by direct substitution, Lagrange Multipliers, Interpretation of Lagrange multipliers, Multivariable optimization with inequality constraints: Khun Tucker conditions(concept only).

Module-2

Nonlinear Programming: One-Dimensional Minimization Methods**,** Introduction, Unimodal Function, Elimination methods: unrestricted search, fixed step size, accelerated step size, Exhaustive search: dichotomous search, interval halving method, Fibonacci method, golden section method, Interpolation methods: Quadratic and cubic interpolation method, direct root method, Newton method, Quasi-Newton method, secant method.

Module-3

Nonlinear Programming: Direct search methods: Classification of unconstrained minimization methods, rate of convergence, scaling of design variables, random search methods, univariate methods, pattern directions, Powell's methods, Simplex method.

Module-4

Nonlinear Programming: Indirect Search (Descent) Methods: Gradient of a function, Steepest decent method, Fletcher Reeves method, Newton's method, Davidson-Fletcher-Powell method.

Module-5

Integer Programming: Introduction, Graphical representation, Gomory's cutting plane method: concept of a cutting plane, Gomory's method for all-integer programming problems, Bala's algorithm for zero–one programming, Branch-and-Bound Method.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Define and use optimization terminology, concepts, and understand how to classify an optimization problem.

CO2: Understand how to classify an optimization problem.

CO3: Apply the mathematical concepts formulate the problem of the systems.

CO4: Analyse the problems for optimal solution using the algorithms.

CO5: Interpret the optimum solution.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Engineering Optimization Theory and Practice	S. S. Rao	John Wiley & Sons	Fourth Edition 2009
2	Optimisation Concepts and Applications in Engineering	A. D. Belegundu, T.R. Chanrupatla,	Cambridge University Press	2011
Reference Books				
1	Engineering Optimization: Methods and Applications	Ravindran, K. M. Ragsdell, and G. V. Reklaitis	Wiley, New York	2nd ed. 2006

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

COMPUTRE AIDED MANUFACTURING LAB

Course Code	**18MEL76**	CIE Marks	40
Teaching Hours /Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
- To educate the students on the usage of CAM packages.
- To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

Sl. No.	Experiments
	PART - A
1	**Manual CNC part programming** using ISO Format G/M codesfor 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool pathusing CNC program verification software.
	PART - B
2	**CNC part programming using CAM packages**. Simulation of Turning, Drilling, Milling operations. 3 typical simulations to be carried out using simulation packages like: **CademCAMLab-Pro, Master-CAM.** Program generation using software. Optimize spindle power, torque utilization, and cycle time. Generation and printing of shop documents like process and cycle time sheets, tool list, and tool layouts. Cut the part in single block and auto mode and measure the virtual part on screen. **Post processingof CNC programs** for standard CNC control systems like **FANUC, SINUMERIC and MISTUBISHI.**
	PART - C
3	**(Only for Demo/Viva voce)** **FMS (Flexible Manufacturing System)**: Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components. **Robot programming:** Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs). **Pneumatics and Hydraulics, Electro-Pneumatics:** 3 typical experiments on Basics of these topics to be conducted.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.

Scheme of Examination:

One question from Part A: 40 marks

One question from Part B: 40 Marks

Viva voce: 20 Marks

Total: 100 Marks

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

DESIGN LAB

Course Code	**18MEL77**	CIE Marks	40
Teaching Hours /Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.

Sl. No.	Experiments
	PART - A
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional).
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor.
	PART - B
5	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending.
6	Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook
7	Determination of Pressure distribution in Journal bearing
8	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain
9	Determination of stresses in Curved beam using strain gauge.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.

CO2: Carry out balancing of rotating masses.

CO3: Analyse the governor characteristics.

CO4: Determine stresses in disk, beams, plates and hook using photo elastic bench.

CO5: Determination of Pressure distribution in Journal bearing

CO6: Analyse the stress and strains using strain gauges in compression and bending test and stress distribution in curved beams.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners

Scheme of Examination:
One question from Part A: 40 marks
One question from Part B: 40 Marks
Viva voce: 20 Marks
Total: 100 Marks

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VIII

ENERGY ENGINEERING

Course Code	**18ME81**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Understand energy scenario, energy sources and their utilization
- Learn about energy conversion methods
- Study the principles of renewable energy conversion systems.

Module-1

STEAM GENERATORS Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, LaMount, Benson, Velox, Loeffer, Schmidt steam generators, Cooling towers and Ponds, Accessories such as Superheaters, De-superheater, Economizers, Air preheaters.

Module-2

Solar Energy: Introduction, Solar radiation at the earth's surface, Solar radiation measurements, Flat plate collectors, Focussing collectors, Solar pond, Solar electric power generation-Solar photovoltaics.
Biomass Energy: Photosynthesis, photosynthetic oxygen production, energy plantation. Bio Chemical Route: Biogas production from organic wastes by anaerobic fermentation, Bio gas plants-KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of biomass, updraft and downdraft

Module-3

Geothermal Energy: Forms of geothermal energy, Dry steam, wet steam, hot dry rock and magmatic chamber systems.
Tidal Energy: Tidal power, Site selection, Single basin and double basin systems, Advantages and disadvantages of tidal energy.
Wind Energy: Wind energy-Advantages and limitations, wind velocity and wind power, Basic components of wind energy conversion systems, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, Applications of wind energy.

Module-4

Hydroelectric plants: Advantages & disadvantages of water power, Hydrographs and flow duration curves-numericals, Storage and pondage, General layout of hydel power plants- components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants, water hammer.
Ocean Thermal Energy: Ocean thermal energy conversion, Principle and working of Rankine cycle, Problems associated with OTEC.

Module-5

NUCLEAR ENERGY Principles of release of nuclear energy-Fusion and fission reactions. Nuclear fuels used in the reactors, Chain reaction, Moderation, breeding, Multiplication and thermal utilization factors. General components of a nuclear reactor and materials, Brief description-Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Shielding, Nuclear waste, Radioactive waste disposal.

Course Outcomes: At the end of the course the student will be able to:
CO1: Understand the construction and working of steam generators and their accessories.