NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Syllabus for

Final Year Mechanical Engineering

Faculty of Engineering and Technology

Teachers, Paper Setters and Examiners Guidelines Manual

SEMESTER – VII and VIII

W.E.F 2015 – 2016

North Maharashtra University, Jalgaon

Syllabus Structure for Final Year Mechanical Engineering w.e.f year 2015-16

Semester –VII

Course Code	Name of the Course	Group	Teaching Scheme				Evaluation Scheme				Total	Credits
							Theory		Practical			
			Theory Hrs /week	Tutorial Hrs /week	Practical Hrs /week	Total	ISE	ESE	ICA	ESE		
	Refrigeration and Air Conditioning	D	3	---	---	3	20	80	---	---	100	3
	Computer Aided Design and Computer Aided Manufacturing	D	3	---	---	3	20	80	---	---	100	3
	Interdisciplinary Elective	E	3	---	---	3	20	80	---	---	100	3
	Elective-I	E	3	---	---	3	20	80	---	---	100	3
	Operation Research	D	3	---	---	3	20	80	---	---	100	3
	CAD/CAM	D	---	---	2	2	---	---	25	25	50	1
	RAC	D	---	---	2	2	---	---	25	25 PR	50	1
	Elective-I	E	---	---	2	2	---	---	25	25	50	1
	Project–I	D	---	---	2	2	---	---	25	25	50	2
	Seminar-II	D	---	---	2	2	---	---	25	---	25	2
	Industrial Visit	D	---	---	---	---	---	---	25	---	25	1
	Total		15	---	10	25	100	400	150	100	750	23

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

	Interdisciplinary Elective		**Elective – I**
1	Operation Research Techniques	1	Mechatronics
2	Energy Resources and Technology	2	Advanced Machine Design
		3	Machine Tool Design
		4	Automobile Engineering – I

- Interdisciplinary Elective shall be offered by the department to the students of other departments. Students from one department can not register for Interdisciplinary Elective of the same department.
- At least 15 students should register for offering any elective.

North Maharashtra University, Jalgaon

Syllabus Structure For Final Year Mechanical Engineering w.e.f year 2015-16

Semester –VIII

Course Code	Name of the Course	Group	Teaching Scheme				Evaluation Scheme				Total	Credits
							Theory		Practical			
			Theory Hrs /week	Tutorial Hrs /week	Practical Hrs /week	Total	ISE	ESE	ICA	ESE		
	Mechanical Vibration	D	3	---	---	3	20	80	---	---	100	3
	Finite Element Analysis and Simulation Techniques	D	3	---	---	3	20	80	---	---	100	3
	Elective-II	E	3	---	---	3	20	80	---	---	100	3
	Elective-III	E	3	---	---	3	20	80	---	---	100	3
	Mechanical Vibration	D	---	---	2	2	---	---	25	25	50	1
	Finite Element Analysis and Simulation Techniques	D	---	---	2	2	---	---	25	25 PR	50	1
	Elective-II	D	---	---	2	2	---	---	25	25	50	1
	Industrial Lecture*	E	---	---	1*	1	---	---	50	---	50	2
	Project–II	D	---	---	4	4	---	---	75	75	150	6
	Total		12	---	11	23	80	320	200	150	750	23

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

	Elective-II		Elective – III
1	Tribology	1	Introduction to Robotics
2	Power Plant Engineering	2	Advanced Welding Technology
3	Process Equipment Design	3	Energy Conservation and Management
4		4	Automobile Engineering – II
		5	Thermal Equipment design

- Minimum 6 lectures to be delivered by experts from the industry in alternate weeks. Next week group discussion on the lecture delivered.
- At least 15 students should register for offering any elective.

Refrigeration and Air Conditioning

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Air Refrigeration systems**	Lecture required
a	Introduction, standard rating of refrigerating machine, coefficient of performance of refrigerator and heat pump.	02
b	Reversed Carnot cycle and its limitations, reversed Brayton cycle, application to air craft refrigeration.	03
c	Bootstrap refrigeration cycle, reduced ambient air cooling system	02
d	Regenerative air cycle system	01
e	Designation of refrigerant, selection of refrigerant, chemical, physical and thermodynamic requirements of refrigerants, lubricant in refrigerating system, secondary refrigerant, azeotropes and its uses.	01
Guidelines for the examiners and paper setters: Theoretical question (4 or 8 marks only) is to be asked on 1.a, 1.b, 1.c. 1.d, 1.e Paper Setter should ask numerical (8 marks only) on 1.a, 1.b, 1.c. 1.d only. No numerical treatment on 1.e.		

Unit-II

Sr. No.	**Vapour compression refrigeration system**	Lecture required
a	Vapour compression refrigeration system study of theoretical and actual vapour compression cycle, use of p-h & T-s charts, effect of evaporator and condenser pressure and temperature on the performance of the refrigeration cycle, effect of sub cooling and super heating.	03
b	Compound vapour compression system with inter cooling	01
c	Compound vapour compression system with flash chamber	01
d	Multi compressor and multi evaporators systems.	02
e	Cascade refrigeration system, production of dry ice.	02
Guidelines for the examiner and paper setter. Theoretical question (4 or 8 marks only) is to be asked on 1.a, 1.b, 1.c. 1.d, 1.e Paper Setter should ask numerical (8 marks only) on 1.a, 1.b, 1.c. 1.d only. No numerical treatment on 1.e.		

Unit - III

Sr. No.	**Vapour absorption refrigeration systems**	Lecture required
a	Simple Vapour absorption refrigeration system	02
b	Modified vapour absorption refrigeration systems, Electrolux refrigerator.	02
c	Desirable properties of solvent, absorbent & refrigerant combinations, aqua ammonia & use of enthalpy concentration charts.	03
d	Lithium bromide refrigeration system.	01
Guidelines for the examiner and paper setter. Theoretical question (4 or 8 marks only) is to be asked on 1.a, 1.b, 1.c., 1.d Paper Setter should ask numerical (8 marks only) on 1.a, 1.b, 1.c only. No numerical treatment on 1.d		

Unit – IV

Sr. No.	**Basic of Psychometric**	Lecture required
a	Psychometric- properties of moist air, psychometric chart and process	02
b	Mixing of air stream, bypass factor, sensible heat factor	02
c	Room sensible heat factor, Gross sensible heat factor, humidifying efficiency, air washer.	03
d	Study of various types of psychrometers, sling, aspirating, and industrial type.	01
Guidelines for the examiner and paper setter. Theoretical question (4 or 8 marks only) is to be asked on 1.a, 1.b, 1.c. 1.d Paper Setter should ask numerical (8 marks only) on 1.a, 1.b 1.c only. No numerical treatment on 1.d.		

Unit – V

Sr. No	**Air Conditioning System**	Lecture required
a	Introduction to industrial and comfort air conditioning, human requirements of comfort, effective temperature and comfort chart.	03
b	Air conditioning load calculations, inside and outside design conditions.	02
c	Building cooling & heating load calculation, Effective sensible heat factor advanced Psychrometry	02
d	Window and central air conditioning systems year round air conditioning.	01
Guidelines for the examiner and paper setter. Theoretical question (4 or 8 marks only) is to be asked on 1.a, 1.b, 1.c. 1.d Paper Setter should ask numerical (8 marks only) on 1.a, 1.b 1.c only. No numerical treatment on 1.d.		

Reference Books:

1. Arora C. P., "Refrigeration and air conditioning", TMH, New Delhi.
2. Monohar Prasad, "Refrigeration and air conditioning", New Age Publishers, New Delhi.
3. Ananthnarayanan, "Basics of Refrigeration", TMH, and New Delhi.
4. Stocker W. F. and Jones, "Refrigeration and air conditioning", McGraw Hill.
5. Dossat, "Principles of Refrigeration", John Wiley Inc.
6. Arora and Domkundawar, "Refrigeration and air conditioning", Dhanpatrai and sons, New Delhi.
7. Faye C McQuistom, "Heating Ventilatgingnad Air conditioning",Wiley India Pvt.Ltd. New Delhi.

Computer Aided Design and Computer Aided Manufacturing

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Introduction To CAD/CAM And Networking**	Lecture required
A	Define CAD/CAM, Product Life Cycle & CAD/CAM	1
B	Application of Computers for Design Process, Selection of a CAD system	1
C	Desirable relationship of CAD/CAM database, Benefits & Application of CAD.	2
D	Hardware in CAD, Introduction	1
E	The Design Work Station, The graphics terminal, Operator input/output devices,	1
F	Computer communication, Principle of networking	1
G	Classification of network, Transmission media & interface, LAN system.	2
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus		

Unit-II

Sr. No	**Computer Aided Graphics**	Lecture required
A	Introduction, Graphic Primitives, Point plotting, Drawing of lines	1
B	Co ordinate system used in graphic element, Transformation in graphics.	1
C	2D transformation, Homogeneous transformation.	2
D	Concatenate co ordinate transformation, Translation, Rotation, Scaling, Mirror, and Reflection.	2
E	Inverse co ordinate transformation, clipping.	1
F	3D transformation, View Port, Windowing, Standardization in graphics IGES files.	2
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus		

Unit-III

Sr. No	**Computer Aided Modeling & Automation**	Lecture required
A	Requirement of Geometric Modeling, Geometric Model	1
B	Geometric Model Construction Method: Wire Frame Modeling, Surface Modeling, Solid Modeling	2
C	Representation of Curve & Surfaces, Design of curve shape, Cubic Spline, Bezier curve, B-spline curve	2
D	Concept of Automation, Types of Automation	1
E	Advantages & limitations of Automation, Levels of Automation, Advanced Automation Function.	2
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus		

Unit-IV

Sr. No	**Computer Aided Manufacturing**	Lecture required
A	Continuous control system, Discrete control system	1
B	Computer process control, Forms of CPC, Computer process Monitoring	2
C	Direct Digital Control, Numerical Control & Robotics, Programmable logic controller	2
D	Distributed Control & Personnel Computers	1
E	Axis of CNC Machines, Manual Part Programming using G and M codes Adoptable to Fanuc Controller for Lathe.	2
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus		

Unit-V

Sr. No	**Introduction to FMS, GT and Robotics**	Lecture required
A	Introduction, Components of FMS, Types of FMS	1
B	Application & Benefits, Planning & implementation issue, Typical FMS layout.	2
C	GT – Part families, Part classification & coding, optic coding system, Multiclass coding system, Application of GT.	2
D	Robotics – Robot Anatomy, Robot Control System	2
E	End effectors, Sensors, Industrial Robot, Application and its selection.	1
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus		

Reference Books:-

1. P. Radhkrishnan, S. Subramanyam, V. Raju ,"CAD/CAM/CIM" , New Age Publication.
2. Grover, Automation, "Production System and Computer Integrated Manufacturing", Pearson Education.
3. Mikell P. Grover, Emory W. Zimmers ,"Computer Aided Design and Manufacturing", P.H.I.
4. Zeid ,"CAD/CAM" ,T.M.H.
5. B.S.Pabla, M.Adithan ,"CNC Machine ", New Age International(P) Ltd.
6. Rao, Tiwari, Kundra ,"Computer Aided Manufacturing" ,T.M.H.
7. CAD/CAM & AUTOMATION by FarazdakHaidri.

Interdisciplinary Elective
Operation Research Techniques

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Linear Programming**	Lecture required
A	The history of OR, Definition, Features, of OR	01
B	models and modeling in OR, methods for solving OR models	01
C	phases of OR, Advantages of OR study, Shortcomings of OR approach, OR Models in Practice, Applications of OR.	01
D	Introduction, general Stricture of LP model, Assumption of an LP model, Advantages and Limitations of Linear programming	01
E	Applications areas of LP, steps of LP Model formulation	01
F	Graphical solution methods of LP problem, maximization.	01
G	Minimization maximization.	01
H	Minimization	01
I	infeasible and unbounded solution	01
Guidelines for Paper Setters: Theoretical questions to be asked on Unit-I A.B.C.D.E.F Numerical questions to be asked on Unit-I F.G.H.I.		

Unit-II

Sr. No.	**Linear Programming**	Lecture required
A	The simplex method Introduction, standard form of an LP problem	01
B	Simplex algorithm (maximization)	02
C	Simplex algorithm (minimisation case)	02
D	Degeneracy in simplex problem, unbounded Infeasible solution.	02
E	Duality in Linear programming, formulation of dual LPP, Advantages of duality, rules for constructing the Dual from primal,	01
F	Sensitivity Analysis in LP	01
Guidelines for Paper Setters: Theoretical questions to be asked on Unit-II A.B.C.D.E.F Numerical questions to be asked on Unit-I I B,C,D,E,F.		

Unit - III

Sr. No.	**Transportation Theory**	Lecture required
A	Transportation problem introduction, mathematical model of transportation problem, Algorithm	01
B	Methods for finding initial solution northwest corner method	01
C	Least cost method, vogels Approximation method	01
D	Test for optimality steps of MODI method,	02
E	Introduction, mathematical models of assignment problem, solution method of assignment problem, Hungarian method	01
F	Maximization case, unbalanced Restrictions on assignment	01
G	Travelling salesman, problem	01
Guidelines for Paper Setters: Theoretical questions to be asked on Unit-III A.B.C.D.E. Numerical questions to be asked on Unit-III B,C,D,E,F.G		

Unit – IV

Sr. No.	**Decision Making Theory**	Lecture required
A	Decision Theory- Introduction, steps in decision making process types of decision making Environments, Decision tree	01
B	Introduction,Two person Zero sum game, pure strategies, maximin, minimax principles	02
C	Game with saddle point	01
D	Mixed strategy games	01
E	The principles of dominance ,games without saddle point	01
F	Algebraic method, arithmetic method, sub game method	01
G	Graphical method	01
Guidelines for Paper Setters: Theoretical questions to be asked on Unit-IV A.B.C.D.E.F Numerical questions to be asked on Unit-IV B,C,D,E,F.G		

Unit – V

Sr. No.	**Sequencing**	Lecture required
A	Replacement and maintenance method- Introduction, types of failure-gradual failure ,sudden failure	01
B	Replacement of items whose efficiency deteriorates with time	01
C	Replacement of items that completely fail	01
D	Individual replacement policy, Group replacement policy	01
E	Staffing problem ,failure trees	01
F	Sequencing problem- Introduction notations, Terminology, and assumptions of sequencing problem	01
G	Processing n jobs through two machines, Processing n jobs through three machines	01
H	Processing n jobs through four machines, Processing n jobs through five machines	01
Guidelines for Paper Setters: Theoretical questions to be asked on Unit-V A.B.C.D. F Numerical questions to be asked on Unit-V B,C,D,E,F.G.H		

Text Book and Reference Books

1. L.C. Jhamb ,"Quantities Techniques" Vol I and II, Everest Publication
2. Hira , Gupta ,"Operation Research.
3. Taha ,"Operation Research".
4. S.D. Sharma, "Operation Research", Khanna Publication.
5. ManoharMahajan, "Operation Research.
6. J.K.Sharma ,"Operation Research, Problem and Solution" , Macmillan.
7. N.D.Vohra ,"Quantitative Techniques in Management" ,TATA McGraw Hill.
8. Ravindran," Operation Research Principles and Practice ",Wiley India Pvt.Ltd. New Delhi

Interdisciplinary Elective

Energy Resources and Technology

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Energy Overview and Thermal Power Plants**	Lecture required
A	Energy Overview: Basics of energy – Types of energy and its utilization – Energy Characteristics	01
B	Energy Measures – global energy scenario – India energy scenario	01
C	Types of energy and its utilization, Environmental aspects of energy utilization – Public health issues related to environmental Pollution	02
D	Overview of Thermal Power Plants, Types of fuels – Coal quality, By products of combustion.	02
E	Thermal power plant cycle, General layout of modern thermal power plants.	02
F	Environmental aspects of thermal power plants.	01
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus		

Unit-II

Sr. No.	**Solar Photovoltaic Energy ConversionNIT-II:**	Lecture required
A	Photovoltaic Conversion, Silicon Solar Cells, Photovoltaic Modules	02
B	Module efficiency, PV panels and arrays, Solar Photovoltaic Systems(SPS)	03
C	Solar PV lighting systems, PV Lanterns, Solar water Pumping	02
D	PV Roof top technology, Life cycle cost estimates.	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Unit - III

Sr. No.	**Solar Thermal Energy Conversion**	Lecture required
A	Liquid Plat Plate collectors, transmissivity, heat losses and heat loss coefficients, thermal analysis	02
B	Concentrating collectors, types, performance analysis of cylindrical parabolic collector.	02
C	Solar water heating system, solar cookers	01
D	Solar Distillation, Solar Cooling, Solar Ponds	02
E	Solar power plants, Concentrated Solar Power Plants.	01
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Unit – IV

Sr. No.	**Wind and Nuclear Energy Conversion**	Lecture required
A	Wind Energy Conversion-Principles of wind energy conversion, Site selection considerations	02
B	Wind, Power plant design, Types of wind power conversion systems	01
C	Operation, maintenance and economics	01
D	Nuclear Energy Conversion - Chemical and nuclear equations, Nuclear reactions, Fission and fusion	01

E	Energy from fission and fuel burn-up , Radioactivity , Neutron energies	01
F	Fission reactor types, Nuclear power plants, Fast breeder reactor and power plants, Production of nuclear fuels.	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Unit - V

Sr. No.	**Biomass, Geothermal and Ocean Thermal Energy Conversion**	Lecture required
A	Energy from biomass - Sources of biomass ,Different species, Conversion of biomass into fuels	02
B	Energy through fermentation, Pyrolysis, gasification and combustion	01
C	Aerobic and anaerobic bio-conversion, Properties of biomass, Biogas plants	01
D	Types of plants, Design and operation, Properties and characteristics of biogas.	01
E	Geothermal energy – Availability, system development and limitations	01
F	Ocean thermal energy conversion – Wave and tidal energy – Scope and economics	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Text Book and Reference Books

1. K.M. Mittal: Non-conventional Energy Systems-Principles, Progress and Prospects, Wheeler Publications, 1997.
2. Kothari: Renewable Energy Sources and Emerging Technologies, PHI, Eastern Economy Edition, 2012
3. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002.
4. M.M. E1- Wakil; Power Plant Technology, McGraw Hill, 1985.
5. M.M. E1-Wakil: Nuclear Power Engineering, McGraw Hill, 1962.
6. Mukherjee and Chakrabarti, Fundamentals of Renewable Energy systems, New age International Publishers, 2004.
7. S.P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage,Tata McGraw Hill,2003.

Elective-I

Mechatronics

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Introduction to Mechatronics system**	Lecture required
A	Mechatronics system, Modeling and Design.	01
B	Design concept evolution, Application areas.	01
C	Dynamic Models, Model types ,Model Development	02
D	Lumped model of a distributed system	01
E	Kinetic energy equivalence, Natural frequency equivalence, Analogies to mechanical	02
F	electrical, thermal and fluid elements	02
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus. Numerical should be asked on topics d and e.		

Unit-II

Sr. No.	**Component Interconnection ,Signal Conditioning**	Lecture required
A	Introduction to Basic components, need of interconnections, impedance characteristics.	03
B	Resistance, inductors, capacitors, amplifiers.	02
C	Introduction to Analog and digital filters, Analog to Digital and Digital to Analog converters	02
D	Bridge circuits (Wheatstone, Maxwell), Signal Analyzers and Display devices.	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus. Numerical should be asked on each topics		

Unit – III

Sr. No.	**Sensors and Transducers**	Lecture required
A	Motion transducers, potentiometer, variable inductance transducers, Permanent magnet transducers,	02
B	variable capacitance transducers, Piezoelectric Sensors, Effort Sensors, strain gauges, torque sensors, tactile sensors.	02
C	Optical sensor and Lasers, Thermo-Fluid Sensors, shaft encoders	02
D	optical encoders, Digital tachometer, Hall effect Sensors, Linear encoders, Digital resolvers	02

Unit – IV

Sr. No.	**Electrical Actuators**	Lecture required
A	Stepper motors, construction and Principle of operation, torque motion characteristics	01
B	damping, control, selection and applications of stepper motors	01
C	D.C. motors, construction and operations, static torque	02

	characteristic, brushless D. C. Motors, control and selection of D.C. Motor	
D	Induction Motors, construction, working, characteristic	02
E	Torque speed relationship, Consecution, working and control of synchronous motors.	02

Unit – V

Sr. No.	**Mechanical Actuators**	Lecture required
A	Linear Actuators, Hydraulic Actuators	01
B	Pneumatic actuators, components of Hydraulic control system	02
C	Pumps, motors, valves	02
D	feedback control, constant flow systems, pump controlled hydraulic actuators	01
E	pneumatic control system, Flapper valves, and hydraulic circuits	02

Reference Books:

1. Clarence W de Silva, Mechatronics: An Integrated Approach, CRC Press ISBN 0849312744
2. W Bolton, Mechatronics: A multi-disciplinary approach, Fourth edition, Pearson education ISBN 9788131732533.
3. Boucher, T. O., Computer automation in manufacturing - an Introduction, Chapman and Hall, 1996.
4. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
5. Deb, S. R., Robotics technology and flexible automation, Tata McGraw-Hill, New Delhi, 1994.
6. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 1999.

Elective-I

Advanced Machine Design

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**CAMS**	Lecture required
A	Advanced curves: 2-3 polynomial, 3-4-5 polynomial	01
B	4-5-6-7 polynomial & higher order polynomial.	02
C	Polydyne cams: 3-4-5 cam, cycloidal cam.	02
D	Pressure angle, radius of curvature, force on follower and cam	02
E	Cam design with elasticity of part is considered, ramps.	02

Unit-II

Sr. No	**Springs**	Lecture required
A	Helical springs under static and fatigue or variable loading, buckling of helical compression spring	03
B	vibration and surging of helical springs, Optimum design of helical spring	03
C	Design analysis of Belleville springs, ring spring, volute spring, rubber springs and mountings.	03

Unit-III

Sr. No	**Design Against Fatigue**	Lecture required
A	Fatigue Damage theories, Cycle counting Techniques, Stress based fatigue Analysis.	02
B	Design: one dimensional analysis, multiaxial analysis, and Cumulative damage.	02
C	Strain based fatigue Analysis & design: one dimensional analysis, multiaxial analysis	02
D	Surface integrity & fatigue life improvement.	02

Unit-IV

Sr. No	**System Approach**	Lecture required
a	Introduction, System approach to design mathematical model	02
b	Dynamic response to a distributed system, Dynamic response to a lumped system	02
c	Modeling the elasticity's, Modeling the masses, Modeling the inertia, Modeling friction and damping	02
d	Mathematical model for shock analysis, Cam system, Value engineering approach to design problem.	02

Unit-IV

Sr. No	**Optimum Design**	Lecture required
a	Introduction to optimum design, Adequate design	02
b	Johnson's method of optimum design.	02
C	Case of normal specifications, Case of redundant specifications	02
d	Case of incompatible specifications.	02

References:

1. Dr. RajendraKarwa ," A text book of Machine Design", Laxmi Publications (P) Ltd, New Delhi.
2. J. Uicker,"Theory of Machines and Mechanism", 3ed., Oxford University Press, New Delhi.
3. FarazdakHaideri ," Machine Design", NiraliPrakashan.
4. M.F. Spotts," Design of Machine Elements", Pearson Education.
5. N.C.Pandya ," Element of Machine Design", Charotar book stall, Anand.
6. Norton ," Dynamics of Machinery", Tata Mc-Graw Hill, New Delhi.
7. P.C.Sharma ,"Machine Design", S K Katuria& Sons.
8. R. S. Khurmi ," A text book of Machine Design", Eurasis Publishing House Pvt. Ltd, Delhi.
9. R.B.Patil ,"Design of Machine Elements", Tech- Max Publications, Pune

Elective-I

Machine Tool Design

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Principles of Machine Tool Design and Drives**	Lecture required
A	Introduction – Machine tools, classification. Working and auxiliary motion in machine tools.	01
B	Mechanical and Hydraulic transmission elements.	01
C	Devices for Intermittent motion. Reversing and differential mechanism.	01
D	General requirement of machine tool design. Engineering Design process applied to machine tools.	01
E	Machine tool drive – Types of speed and feed regulation, classification of speed and feed boxes.	01
F	Design of speed box - Stepped regulation of speed, selection of range ratio, geometric progression, structural diagram.	02
G	Design of feed box in details.	01
H	Development of gearing diagram.	01

Unit-II

Sr. No	**Design of machine tool structure**	Lecture required
A	Function of machine tool, structure and their requirements, design criteria for machine tool structure.	01
B	Materials and its properties, dynamic and static stiffness.	01
C	Profile of machine tool structure, factors affecting on the stiffness of machine tool structures.	02
D	Basic design procedure machine tool structure.	01
E	Design of beds and columns.	01
F	Design of Housing, Design of bases and tables.	01
G	Design of Cross rails, arms, saddle and carriages.	01
H	Design of Rams.	01

Unit-III

Sr. No	**Design of Guide ways and power Screws**	Lecture required
A	Function and types of Guide ways, types of slide ways and types of anti friction ways.	01
B	Design of slide ways – Shapes, materials, method of adjusting clearance in slide ways.	01
C	Design criteria and calculation for slide ways – (i) for wear (ii) for stiffness	01
D	Guide ways operating under liquid friction conditions – (i) hydrodynamic slide ways (ii) Hydrostatic slide ways	01
E	Design of Aerostatic and anti-friction guide ways.	01
F	Combination guide ways and protecting devices for slide ways.	01
G	Design of Power screw – (i) Design of sliding friction power screw	01
H	(ii) Design of rolling friction power screw.	01

Unit-IV

Sr. No	**Design of Spindles and Spindle supports.**	Lecture required
A	Function of spindle unit and requirement, material of spindle	01
B	Effect of machine tool compliance on machinery accuracy.	01
C	Design calculation of spindles – Deflection of spindle axes due to	01

D	bending and compliance of spindle support. Optimum spacing between spindle support. Deflection due to compliance of tapered joint permissible deflection and design for stiffness.	01
E	Anti-friction bearings and sliding bearings.	01
F	Dynamics of machine tools – Forced vibration in machine tools.	01
G	Dynamic characteristics of machine elements	01
H	Stability analysis – Static and dynamic cutting processes, characteristics. Regenerative chatter.	01

Unit-V

Sr. No	**Control System in Machine tools and Industrial Robots.**	Lecture required
A	Function, requirements and classification, control system for changing speeds and feed with simple centralized control	01
B	Control system for changing speeds and feed with pre-selective control Control system for changing speeds and feed with Selective control	01
C	Control system for executing and forming auxiliary motion. Manual control system.	01
D	Automatic control system and adaptive control system.	01
E	Industrial robot and its application.- Introduction and basic function of robotic elements, mobility of robot.	01
F	Reliability in operation and various control system in robots.	01
G	Robot language – Robot language outline, general description of programming language. Real time, geometric modeling, movements.	01
H	Sensors, tools, programming ARL, HARL, AL, VAL, AML, IRL, LM and MCL.	01

Reference Books:

1. D. K Pal, S. K. Basu, "Design of Machine Tool", 4th Edition. Oxford IBH 2005, ISBN 81-204-0968.
2. F. Koenigsberger, "Design Principles of Metal Cutting Machine Tools", The Macmillan Company New York 1964.
3. Bhattacharya and S. G. Sen., "Principles of Machine Tool", New central book agency Calcutta, ISBN 81-7381-1555.
4. N. S. Acherkan, "Machine Tool", Vol. I, II, III and IV, MIR publications.
5. N.K. Mehta, "Machine Tool Design", Tata McGraw Hill, ISBN 0-07-451775-9.
6. DR. V. P. Singh, "Mechanical Vibration", S. Chand &Sons., New Delhi.

Elective-I
Automobile Engineering – I

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Introduction to Automobile**	Lecture required
A	Introduction to Automobile, History of Automobile, Types of Automobile, Automobile Industry	2
B	Special Purpose Vehicle, Chassis, Classification of Chassis, Integral and Chassis less Construction	2
C	Frame, Function s of the frame, Types of the Frame, Defects in Frame, Sub Frame, Body	2
D	Introduction to Safety System, Seat Belt System, Power Seats, Air Bag System, Electric Mirrors,	1
E	Central Locking and Electric Window, Electric Horns, Windscreen Wiper System, Analog and Digital Speedometer	2
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus, numerical on a to c based on speed control, torque and braking.		

Unit-II

Sr. No.	**Automobile Suspension**	Lecture required
A	Introduction, Function of Suspension system, Requirements of a Suspension System, Torque Rod	2
B	Stabilizer Bar, Air Suspension, Hydraulic Suspension	2
C	Types of Suspension Spring, Plastic springs for motor cars, Shackle, Shock Absorber	2
D	Front Axle Suspension System	1
E	Rear Suspension System, Spring and Suspension trouble shooting chart	2
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus, numerical on each topic.		

Unit – III

Sr. No.	**Automobile Steering**	Lecture required
a	Introduction, Principle of Correct Steering, Requirements of steering system, Steering system functions	2
b	General arrangement of steering system, Steering gears and linkages	2
c	Power steering, Reversible and irreversible steering, Factor Affecting under-steering and over-steering	2
d	Steering Gear, Steering gear ratio, Turning radius, Wheel alignment, Caster and Camber angle, Toe-in Toe-out, Steering Trouble and Causes, Factor Affecting the Steering Operation	2
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Unit – IV

Sr. No.	**Automobile Wheels, Tyres and Tubes**	Lecture required
a	Introduction, Wheel Assembly, Wheel and Tyre Sizes, Types of wheels, Wheels balance, Rims	2
b	Tyres, Types of tyres, Tyres Construction and Constituents, Tyres thread Patterns, Load Ratings	2
c	Tyres Selections and Tyre Properties, Tyres Pressure and wear, Causes of Tyre Wear, Tyre size, Tyres maintenance, Factors increase life of tyres	2
d	Tubes , Types of Tubes, Wheels and tyre troubles	2
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Unit – V

Sr. No.	**Automobile Transmission (Gear Box & Clutch)**	Lecture required
a	Introduction, Purpose of Transmission, Types of Transmission, Gear-boxes with different speed gear	1
b	Three speed and Four speed Gear-box, Gear shifting, Gear box troubles Lubrication of gear box	1
c	Introduction., Clutch and its functions, Principles of Operations, Requirement of Clutch, Main Parts of clutch	2
d	Types of friction materials, Properties of good clutch lining, Types of clutches, Clutch Maintenance	2
e	Clutch troubles and their causes Factors Affecting the Power Transmitted by the Clutch, Propeller Shaft, Universal Joint, Rear Axle	2
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Reference Books:

1. Automobile Engineering Vol. 1 & 2 by Dr. Kripal Singh, (Standard Publishers Distributors).
2. A textbook of Automobile Engineering I & II by P. S. Gill, (S. K. Kataria& Son's).
3. Automobile Engineering by R. B. Gupta, (SatyaPrakashan).
4. Automobile Engineering by Dr. V. M. Domkundwar, (DhanpatRai&Company).
5. A textbook of Automobile Engineering by R. K. Rajput, (Laxmi Publication Pvt. Ltd.).
6. Automobile Engineering by K. M. Moeed, (S. K. Kataria& Son's).
7. Automobile Engineering by Dr. A. K. Basu, (S. Chand Company Pvt. Ltd.)

Operation Research

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Linear Programming**	Lecture required
a	The history of OR, Definition, Features, of OR	01
b	models and modeling in OR, methods for solving OR models	01
c	Phases of OR, Advantages of OR study, Shortcomings of OR approach, OR Models in Practice, Applications of OR.	01
d	Introduction, general Stricture of LP model, Assumption of an LP model, Advantages and Limitations of Linear programming	01
e	Applications areas of LP, steps of LP Model formulation	01
f	Graphical solution methods of LP problem, maximization.	01
g	Minimization	01
h	Minimization	01
i	infeasible and unbounded solution	01

Guidelines for Paper Setters: Theoretical questions to be asked on Unit-I A.B.C.D.E.F
Numerical questions to be asked on Unit-I F.G.H.I.

Unit-II

Sr. No.	**Linear Programming**	Lecture required
a	The simplex method Introduction, standard form of an LP problem	01
b	Simplex algorithm (maximization)	02
c	Simplex algorithm (minimisation case)	02
d	Degeneracy in simplex problem, unbounded Infeasible solution.	02
e	Duality in Linear programming, formulation of dual LPP, Advantages of duality, rules for constructing the Dual from primal,	01
f	Sensitivity Analysis in LP	01

Guidelines for Paper Setters:
Theoretical questions to be asked on Unit-II A.B.C.D.E.F
Numerical questions to be asked on Unit-I I B,C,D,E,F.

Unit - III

Sr. No.	**Transportation Theory**	Lecture required
a	Transportation problem introduction, mathematical model of transportation problem, Algorithm	01
b	Methods for finding initial solution northwest corner method	01
c	Least cost method, vogels Approximation method	01
d	Test for optimality steps of MODI method,	02
e	Introduction, mathematical models of assignment problem, solution method of assignment problem, Hungarian method	01
f	Maximization case, unbalanced Restrictions on assignment	01
g	Travelling salesman, problem	01

Guidelines for Paper Setters:
Theoretical questions to be asked on Unit-III A.B.C.D.E.
Numerical questions to be asked on Unit-III B,C,D,E,F.G

Unit – IV

Sr. No.	**Decision Making Theory**	Lecture required
a	Decision Theory- Introduction, steps in decision making process types of decision making Environments, Decision tree	01
b	Introduction,Two person Zero sum game, pure strategies, maximin, minimax principles	02
c	Game with saddle point	01
d	Mixed strategy games	01
e	The principles of dominance ,games without saddle point	01
f	Algebraic method, arithmetic method, sub game method	01
g	Graphical method	01
Guidelines for Paper Setters: Theoretical questions to be asked on Unit-IV A.B.C.D.E.F Numerical questions to be asked on Unit-IV B,C,D,E,F.G		

Unit – V

Sr. No.	**Sequencing**	Lecture required
a	Replacement and maintenance method- Introduction, types of failure-gradual failure ,sudden failure	01
b	Replacement of items whose efficiency deteriorates with time	01
c	Replacement of items that completely fail	01
d	Individual replacement policy, Group replacement policy	01
e	Staffing problem ,failure trees	01
f	Sequencing problem- Introduction notations, Terminology, and assumptions of sequencing problem	01
g	Processing n jobs through two machines, Processing n jobs through three machines	01
h	Processing n jobs through four machines, Processing n jobs through five machines	01
Guidelines for Paper Setters: Theoretical questions to be asked on Unit-V A.B.C.D. F Numerical questions to be asked on Unit-V B,C,D,E,F.G.H		

Text Book and Reference Books

1. L.C. Jhamb ,"Quantities Techniques" Vol I and II, Everest Publication
2. Hira , Gupta ,"Operation Research.
3. Taha ,"Operation Research".
4. S.D. Sharma, "Operation Research", Khanna Publication.
5. ManoharMahajan, "Operation Research.
6. J.K.Sharma ,"Operation Research, Problem and Solution" , Macmillan.
7. N.D.Vohra ,"Quantitative Techniques in Management" ,TATA McGraw Hill.
8. Ravindran," Operation Research Principles and Practice ",Wiley India Pvt.Ltd. New Delhi

Computer Aided Design and Computer Aided Manufacturing

(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	2D drawing using sketcher- 2 Drawings	02
2	3D modeling using 3D features (Modeling of Screw jack, Brake Pedal, Clutch, Steering linkages, Carburetor, F.I.P., *any four components*)	02
3	Assembling and drafting (Any 2 above mentioned assemblies) with proper mating conditions and interference checking	02
4	Surface Modeling (Any 2 of the above assemblies). 4 Hrs.	04
5	Manual Part programming on CNC Lathe and CNC Milling to generate tool Path, NC Code and optimization of tool path (to reduce machining time) Using any cam software. 4 Hrs.	04

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-

In ESE the student may be asked questions on prescribe journal. Evaluation will be based on answers given by students in oral examination.

Refrigeration and Air Conditioning

(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

Sr. No		Lecture required
1	Trial on vapour compression refrigeration system	02
2	Trial on ice plant/domestic refrigeration system.	02
3	Study and trial on vapour absorption refrigeration system.	02
4	Study and trial on window/central air conditioner.	02
5	Study and trial on heat pump test rig.	02
6	Study of construction of hermetically sealed compressor and actual viewing of a cut model of the same (reciprocating, rotary and car A/C compressor).	02
7	Study of evacuation and charging of refrigeration system	02
8	Study and trial on cooling towers.	02
9	Study of expansion devices, solenoid valve and safety devices used in vapor compression system.	02
10	Study of thermostat and humidistat, dryer, oil separator.	02
11	Study of measuring instruments and various tools used in refrigeration and air-conditioning systems.	02
12	Visit to cold storage/ice plant/ central air conditioning system.	02

13	Cooling load calculation of any laboratory / class room in the institute & suggest the requirement of Air conditioner unit in terms of capacity.	02

Note: Lab file should consist of minimum **Eight** experiments.

Guide lines for ICA:
ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-
The Practical Examination will comprise of performing the experiment and viva on the Practical's.

Instructions for practical Exam:-

1. Four experiments should be selected for Practical Examination.
2. The Number of Students for each Practical set up should not be more than 5 Students.
3. Oral will be based on the Practical Performed in the examination and the experiments included in the Journal.

Elective-I
Mechatronics
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	Study of Basic block diagram of Mechatronics system components.	02
2	Study and demonstration of motion / force transducers.	02
3	Study and demonstration of temperature / pressure transducers.	02
4	Study and demonstration of AD / DA converter	02
5	Study and demonstration of hydraulic actuator / pneumatic actuator.	02
6	Study and demonstration of graphic / magnetic tape recorders.	02
7	Study of Microprocessors and Microcontrollers	02
8	Study of Robot / Autonomous guided vehicle	02

Note: Lab file should consist of minimum **Five** experiments.

Guide lines for ICA:
ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-
In ESE the student may be asked questions on the prescribed certified journal Evaluation will be based on oral examination.

Elective-I
Advanced Machine Design Lab
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	2 assignments	04
2	2 drawing sheets	04
3	2 design software based problems	04

Note: Lab file should consist of two assignments, two drawing sheets and two design software based problems based on above syllabus.

Guide lines for ICA:
ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-
In ESE the student may be asked questions on the prescribed certified journal Evaluation will be based on oral examination.

Elective-I
Machine Tool Design
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

Term work shall consist of minimum five assignments and drawing sheet based on above syllabus covering all units

Guide lines for ICA:
ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-
In ESE the student may be asked questions on the prescribed certified journal Evaluation will be based on oral examination.

Elective-I
Automobile Engineering – I
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	Study of layout of a chassis and its different components of a vehicle.	02
2	To study model trends in automobile	02
3	Study of trouble shooting in various suspension systems.	02
4	Study of trouble shooting in power steering.	02
5	Measurement of steering geometry angle for wheels alignment.	02
6	Study of impact on steering geometry angle of vehicle	02
7	Study of different types of tyres, tubes and their defects.	02
8	Visit to wheel balancing and alignment center.	02

Note: Term work Lab file should consist of minimum six practical's from above list

Guide lines for ICA :

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-

In ESE the student may be asked questions on the prescribed certified journal Evaluation will be based on oral examination.

Project-I
(Lab Course Contents)

1	Every student of Final Year shall undertake the Project-I in semester VII. It is expected that the broad area of Project-I shall be finalized by the student in the beginning of the VII semester and extension of Minor project undertaken may be of Project-I.
2	A group of Minimum **3** and Maximum **5** students shall be allotted for Project-I and same project group for Project-II.
3	Project-I may involve fabrication, design or investigation of a technical problem that may take design, experimental or analytical character or combine element of these areas. The project work shall involve sufficient work so that students get acquainted with different aspects of fabrication, design or analysis.
4	Each student group is required to maintain log book for documenting various activities of Project-I and submit group project-I report in the form of thermal bound.
5	The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Project-I. Maximum four Project-I groups shall be assigned to one teaching staff.

Guide lines for ICA: The Internal Continuous Assessment shall be based on the active participation of the students in the Project work and knowledge / skill acquired. Assessment of the project-I for award of ICA marks shall be done jointly by the guide and departmental

committee as per the guidelines given in Table-A.

Guide lines for ESE: The End Semester Examination for Project shall consist of demonstration if any, presentation and oral examinations based on the project report.

Assessment of Project-I

Name of the Project: _____

Name of the Guide: _____

Table-A

SN	Name of Student	Problem Identification and project objectives	Literature Survey	Project Methodology/Design/ PCB/ hardware/ simulation/ programming	Progress Status	Presentation	Total
			5	5	5	10	25

Seminar-II

1	For Seminar-II every student will individually study a topic assigned to him / her and submit a report and shall deliver a short lecture / Seminar on the topic at the end of term.
2	The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Seminar-II. Seminar shall be related state of the art topic of his choice approved by the committee.
3	Seminar topic should not be repeated and registration of the same shall be done on first come first serve basis.
4	Topic of Seminar shall be registered within a two week from commencement of VII Semester and shall be approved by the committee.
5	Maximum six seminar supervision shall be allotted to each teacher.
6	Every student should deliver a seminar as scheduled (specified in time table)and submit the seminar report (paper bound copy/Thermal bound)in following format: a. Size of report shall be of minimum 25 pages. b. Student should preferably refer minimum five reference books / magazines/standard research papers. c. Format of report i. Introduction. ii. Literature survey. iii. Theory 1) Implementation 2) Methodology 3) Application 4) Advantages, Disadvantages. iv. Future scope. v. Conclusion.

Guide lines for ICA : ICA shall be based on topic selection , presentation and Seminar-II report submitted by the student in the form of thermal bound. Assessment of the Seminar-II for award of ICA marks shall be done by the guide and a departmental committee jointly, as per the guidelines given in **Table- B**

Name of Guide: _____

Table-B

SN	Name of Student	Seminar Topic	Topic Selection	Literature survey	Report writing	Depth of under-standing	Presen-tation	Total
			5	**5**	**5**	**5**	**5**	**25**

Industrial Visit

1	Industry visits to minimum two industries shall be carried out by each student preferably or college shall arrange the industrial visit during the vacation period otherwise during the regular VII semester.
2	During B.E. First Term /During vacation after TE. Second Term every student shall visit industry, major power plant arranged by colleges and accompanied by teachers. There shall be at least one teacher for a group of 20 students, lady teachers for girls and at least one non-teaching staff accompanied with the students.
3	The colleges should obtain appropriate certificates of visit from the concerned organizations just after the visits.
4	Every Student should submit Industrial Visit report individually at the end of Semester-VII(First Term of Final Year)
5	The report should contain information about the following points: a. The organization - activities of organization and administrative setup technical personnel and their main duties. b. The project *I* industry brief description with sketches and salient technical information. c. The work *I* processes observed with specification of materials, products, equipments etc. and role of engineers in that organization. d. Suggestions (if any) for improvement in the working of those organizations. e. The evaluation of the report of technical visits will be made by panel of three teachers appointed by principal based on following points: i. Coverage aspect: All above points should be covered. ii. Detailed observations: System *I* Process / Product explained with data, diagram specifications. iii. Quality of presentation: Report should be very objective and should consist of clear and systematic organization of topics and information. iv. Viva - voce: A viva -voce shall be conducted on the technical visit report by the teachers to assess the specific knowledge gained by the students for technical applications.

Guide lines for ICA: ICA shall be based on knowledge gain by student and Industrial Visit Report submitted by the student in the form of thermal bound. Assessment of the Industrial Visit for award of ICA marks shall be done by departmental committee jointly based on viva -voce shall be conducted on the technical visit report by the teachers to assess the specific knowledge gained by the students for technical applications.

Assessment of Industrial Visit
Table-C

SN	Exam Seat No	Name of Student	Name of Industry	Report writing	Depth of Understanding	Total
				15	10	25

NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Syllabus for

Final Year Mechanical Engineering

Faculty of Engineering and Technology

Teachers, Paper Setters and Examiners Guidelines Manual

SEMESTER –VIII

W.E.F 2015 – 2016

Mechanical Vibration

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Fundamental of Vibrations & Undamped Free Vibrations of Single Degree of Freedom Systems**	Lecture required
A	Fundamental of Vibrations **:-** Introduction, Definitions, Vector method of representing harmonic motions	02
B	Addition of two simple harmonic motions of the same frequency, Beat phenomenon.	01
C	Complex method of representing harmonic vibrations, Work done by a harmonic force on a harmonic motion.	02
D	Undamped Free Vibrations of Single Degree of Freedom Systems: - Introduction, Derivation of differential equation	01
E	Solution of differential equation, Torsional vibrations, Equivalent stiffness of spring combinations, Energy method	03

Unit-II

Sr. No.	**Damped Free Vibrations of Single Degree of Freedom Systems & Forced Vibrations of Single Degree of Freedom Systems**	Lecture required
A	Damped Free Vibrations of Single Degree of Freedom Systems**: -** Introduction, Different types of dampings	01
B	Free vibrations with viscous damping, Logarithmic decrement.	01
C	Viscous dampers, Dry friction or coulomb damping, Solid or structural damping, Slip or interfacial damping	02
D	Forced Vibrations of Single Degree of Freedom Systems**:-** Introduction, Forced vibrations with constant harmonic excitation	01
E	Forced vibrations with rotating and reciprocating unbalance, Forced vibrations due to excitation of support	02
F	Energy dissipated by damping, Forced vibrations with coulomb damping, Forced vibrations with structural damping, Vibration isolation and transmissibility.	02

Unit - III

Sr. No.	**Two Degree of Freedom Systems & Critical speed of shaft**	Lecture required
A	Two Degree of Freedom Systems:-Introduction, Principal modes of vibration, Other cases of simple two degree of freedom systems, Combined rectilinear and angular modes.	03
B	Undamped forced vibrations with harmonic excitation, Vibration absorbers	02
C	Critical speed of shaft- Introduction, critical speed of light shaft having single disc without damping, critical speed of light shaft having single disc with damping	03

Unit – IV

Sr. No.	**Multi Degree of Freedom Systems Exact Analysis & Multi Degree of Freedom Systems Numerical Methods**	Lecture required
a	Multi Degree of Freedom Systems Exact Analysis: - Introduction, Free vibrations equations of motion, Influence coefficients, Generalized coordinates and coordinate coupling.	02
b	Natural frequencies and mode shapes, Forced vibrations by Newtons second law of motion, Torsion vibrations of multi-rotor systems	03

c	Multi Degree of Freedom Systems Numerical Methods: **-** Introduction, Rayleigh's method, Dunkerley's method, Stodola's method	03

Unit – V

Sr. No.	**Continuous Systems& Non-Linear Vibrations**	Lecture required
A	Continuous Systems**: -** Vibrations of strings, Longitudinal vibrations of bars, Torsional vibrations of circular shafts, Lateral vibrations of beams	03
B	Non-Linear Vibrations**: -** Introduction, Examples of non-linear systems, Phase plane, Undamped free vibration with nonlinear spring forces	03
C	Pertubation method, Forced vibration with non-linear spring forces, Self excited vibrations	02

Reference Books: -.

1. Dilip Kumar Adhwarjee "Theory and Applications of Mechanical Vibrations" Laxmi Publications (p) Ltd., New Delhi
2. G.K. Grover "Mechanical Vibrations" New Chand & Bros Roorkee (U.P.)
3. Leonard Meirovitch "Element of Vibration Analysis" Tata McGraw-Hill Publishing Company Limited, New Delhi.
4. Singiresu S. Rao "Mechanical Vibrations "Pearson Education Ptd. Ltd., Delhi.
5. S. Graham Kelly " Schaum'sOut lines Mechanical Vibrations " Tata McGraw-Hill Publishing Company Limited, New Delhi.
6. Thompson," Theory of Vibration with Application", Pearson Education.
7. V.P.Singh "Mechanical Vibrations " DhanpatRai& Co. (P) Ltd., Delhi.
8. B.H.Tongue," Principles of Vibration", 2/ed. Oxford University Press, New Delhi.
9. Sadhu singh "Mechanical vibration & Noise control" published by Khanna Publisher New delhi.

Finite Element Analysis and Simulation Techniques

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Introduction to FEA**	Lecture required
a	Introductory Concepts: Introduction to FEM , Discritization going from part to whole approach	1
b	Physical problem, mathematical models and finite element solution, FEA as a integral part of CAD.	1
c	FEM Software's - Preprocessing, processing and post processing. Advantages and disadvantages of FEM.	1
d	Conventional Numerical Methods- Finite difference method, weighted residual techniques, method of Least squares	2
e	Galerkin methods, Rayleigh- Ritz method, and Boundary Value problems, Displacement methods, equilibrium method.	2
f	Finite Elements Types: One dimensional element such as two nodded & three nodded Spar or truss element.	1
g	Two and three dimensional elements, triangular, rectangular quadrilateral.	1
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus. Numerical may be asked on each topics		

Unit-II

Sr. No.	**One-Dimensional Analysis**	Lecture required
a	Discritization. Derivation of Shape functions, interpolation function	1
b	Stiffness matrices, global stiffness matrix, application of boundary, and force vectors.	1
c	Assembly of Matrices - solution of problems in one dimensional structural analysis, Stepped and Taper Bars	1
d	Torsion of circular shaft, thin valve tubes steady state heat conduction & convection, laminar pipe flow.	2
e	FEM direct approach elements stiffness, potential energy approach	2
f	Treatment of boundary conditions, temperature effects.	1
g	Analysis of Plane Trusses, Analysis of Beams.	1
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus. Numerical may be asked on each topics		

Unit - III

Sr. No.	**Two-Dimensional Analysis**	Lecture required
a	Introduction. Finite element analysis for two dimensional problems.	2
b	Natural coordinates and coordinates transformations	1
c	Derivation of shape functions for triangular element.	1
d	Application of heat transfer, analysis of structural vibration	2
e	Finite element formation of beams.	2
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus. Numerical may be asked on each topics		

Unit – IV

Sr. No.	**Two Dimensional Vector analysis**	Lecture required
a	Equations of elasticity – Plane stress, plane strain problems.	1
b	Automatic mesh generation and imposition	1
c	Eigen value problems.	1
d	Jacobian matrix, stress analysis of CST element.	2
e	Applications to free vibration problems of rod and beam.	2
f	Lumped and consistent mass matrices.	1
Guidelines for the examiners and paper setters: Questions should not be asked on introductory part of syllabus. Numerical may be asked on each topics		

Unit - V

Sr. No.	**Simulation Theory and Application**	Lecture required
a	concepts of a system, system environment, stochastic activities	1
b	Continuous and discrete systems, system modeling, types of models, principles used in modeling, types of system studies.	1
c	System simulation:-The techniques of simulation, Monte Carlo method, comparison of simulation and analytical methods	2
d	analog computers and methods, hybrid computer, simulators, continuous system simulation languages	1
e	system dynamics, growth models, logistic curves, multi segments models, probability concepts in simulation	2
f	System simulation, events, representation of time, arrival pattern.	1
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus.		

Reference Books:-

1. J.N. Reddy, an Introduction to Nonlinear Finite Element Analysis, OUP.
2. C.S. Krishnamoorthy., Finite element analysis TMH
3. J.N. Reddy, Finite element methods, Mcgraw hill publication ltd.
4. Robert Cook, Concept an application of Finite element analysis
5. Klaus-JurgenBhate, finite element analysis, PHI
6. C.S. Desai and J.F. Abel, Introduction to finite element methods ,CBS
7. Tirapati R. Chandrupatla, Finite element analysis by, PHI.
8. Geoffery Gordon ,System simulation
9. NarsinghDeo ,System simulation with digital computers
10. Kenneth Lt. Huebner," The FEM for Engineers", Wiley India Pvt. Ltd. New Delhi

Elective-II

Tribology

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	Introduction to Tribology and friction and Wear	Lecture required
a	Introduction and scope, Tribology in design	01
b	Tribology in Industry, Economical considerations.	01
c	Friction of metals, kinds and measurements of frictions, stick slip oscillation (Vibration) and its elimination	02
d	Theories of friction, frictional heating.	01
e	Wear- Mechanism of wear, types of wear, measurement of wear (wear testing and wear debris analysis)	02
f	Theory of wear, factor affecting on wear rate.	02

Unit-II

Sr. No.	**Lubrication and Hydrostatic bearings**	Lecture required
a	Construction, operation, Advantages, Limitations	01
b	Application of Hydrostatic Bearing (Circular Step bearing)	02
c	Flow rate and pressure distribution, Load carrying capacity and film thickness	02
d	Power losses and temperature rises in Hydrostatic Step bearing.	02
e	Optimum design of hydrostatic step bearing.	02

Unit – III

Sr. No.	**Hydrodynamic Journal Bearing**	Lecture required
a	Theory of hydrodynamic lubrication, Mechanism of Pressure development in oil film.	01
b	Two dimensional Reynold Equation, (i) By Direct method (ii) By Navier's Stokes equation	01
c	Infinitely long Journal Bearing, Infinitely short Journal bearing	02
d	Finite length Journal bearing. Design consideration in hydrodynamic Journal bearing.	01
e	Relations of variable (Raimondi & Boyd). Dimensionless parameters	01
f	Temperature rises and Heat Balance, Pettrof equation.	01
g	Selection of bearing design parameters. Numerical on infinitely long bearing.	01

Unit – IV

Sr. No.	**Hydrodynamic Thrust Bearing and Elastro Hydrodynamic lubrication.**	Lecture required
a	Introduction and analysis of flat pad thrust bearing (tapered pad thrust bearing)	01
b	Analysis of tilting pad thrust bearing and tapper land fixed pad bearing	01
c	Analysis of Reyligh step thrust bearing, spring mounted thrust bearing	01
d	Hydrodynamic pocket thrust bearing,	01
e	Quantity of oil flow with circumferential groove and hole.	01
f	Elastro hydrodynamic lubrication, basic concept, hydrodynamic	02

	equation, Hertz equation for pressure and deformation.	
g	Ertel-Grubin equation. Application of Elastro hydrodynamic lubrication.	01

Unit - V

Sr. No.	**Hydrostatic Squeeze film and gas lubrication.**	Lecture required
a	Introduction, Practical Situation of Hydrostatic squeeze film lubrication. Analysis for a circular plate approaching a plane	01
b	Analysis for a approximation of square plate by using a circular plate. Analysis for rectangular plate approaching a plane.	02
c	Gas Lubrication – Introduction, requirements, merits, demerits and application, Reynold Equation for a gas lubrication.	02
d	Tilting pad air bearing, magnetic recording disc with flying head, porous gas bearings.	02
e	Seals – Classification, functions and application in detail.	01
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Reference Books:

1. Stolarski T.A., "Tribology of Machine Design", Butterworth Heinemann, Oxford, 2000.
2. Bowden F.P. and Tobor D., "Friction and Lubrication of Solids", Clarendon Press, Oxford, 1986.
3. B. C. Majumdar "Introduction Tribology and Bearings", H. Wheeler and Company Pvt. Ltd.
4. Fuller D. D., "Theory and Practice of Lubrication for Engineers". John Wiley and Sons.
5. Cameron A. "Basic Lubrication Theory, Wiley Eastern Ltd.
6. Hrassan& Powel, "Gas Bearing".
7. Halling J. "Principles of Tribology", McMillan Press Ltd.
8. Bharat Bhushan and Gupta B.K., "Handbook of Tribology", McGraw Hill, New Delhi, 1991

Elective-II

Power Plant Engineering

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Thermal Power Plants**	Lecture required
a	Thermal power stations. Main components and working of power stations, thermodynamics cycles	01
b	Fuel handling, combustion and combustion equipment, problem of ash disposal, circulating water schemes and supply of makeup water.	01
c	Choice of pressure of steam generation and steam temperature, selection of appropriate vacuum economizer	02
d	Air pre-heater, feed water heaters and dust collection. Characteristics of turbo alternators, steam power plant, heat balance and efficiency.	01
e	Boilers and steam generation, general classification, fire tube and water tube boilers, natural circulation and forced circulation boilers	02
f	high pressure, high temperature boilers, supercritical pressure boilers, boiler mounting and accessories, feed pumps, economizers, super heaters, air pre-heaters; boiler furnaces, heat generation rates, water walls.	02

Unit-II

Sr. No.	**Diesel and Gas turbine Power Plant**	Lecture required
a	Diesel power plants: Diesel engine performance and operation	02
b	Plant layout, log sheets, selections of engine size.	02
c	Gas turbine plants: Plant layout, methods of improving output and performance fuel and fuel systems	03
d	methods of testing, open and closed cycle plants, operating characteristics	02

Unit - III

Sr. No.	**Hydroelectric and Nuclear Power Plant**	Lecture required
a	Hydroelectric plants: Penstocks, water turbines, specific speed, turbine governors, hydro-plant auxiliaries, plant layout,	02
b	Automatic and remote control of hydro plants, pumped projects, cost of hydroelectric project.	02
c	Nuclear power plants: Elements of nuclear power plants, nuclear reactor fuel moderators, coolants, control.	02
d	Fusion energy: Control through fusion of hydrogen and helium. Energy release rates-present status and problems. Future possibilities.	02

Unit – IV

Sr. No.	**Renewable Energy Power Plant**	Lecture required
a	Basic bio-conversion mechanism; source of waste	02
b	Simple digester; composition and calorific values of bio-gas.	02
c	Wind energy generation; Special characteristics; Turbine parameters and optimum operation; Electrical power generation from wind/tidal energy.	02

d	Ocean thermal energy conversion; Geothermal energy-hot springs and steam injection; Power plant based on OTEC and geothermal springs.	02

Unit - V

Sr. No.	**Solar Energy Power Plant**	Lecture required
a	Energy from the sun: Techniques of collection; Storage and utilisation; Types of solar collectors	02
b	Selective surfaces; Solar thermal processes; Heating; Cooling; Drying; Power generation, etc.	02
c	Direct energy conversion methods: Photoelectric, thermoelectric, thermionic	02
d	MHD (magneto-hydrodynamics) and electro-chemical devices; Solar cells, Solar Concentrators	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Reference Books:

1. Domkundwar and Arora "Power Plant Engineering", DhanpatRai and Sons, New Delhi
2. E.I. Wakil, "Power Plant Engineering", Publications, New Delhi
3. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill, New Delhi
4. R. K. Rajput," Power Plant Engineering", Laxmi Publications, New Delhi.
5. R. Yadav - Steam and Gas turbines, central publishing house, Allahabad
6. G. D. RaiNon conventional energy sources.

Elective-II

Process Equipment Design

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Introduction to Process Equipment Design**	Lecture required
a	Nature of process equipment's, General design procedure.	02
b	Fabrication techniques, choice of materials, resistance to corrosion, Design considerations.	03
c	Stress, Elastic instability, theories of failure, creep, economic consideration	02
d	theories of failure, creep, economic consideration	02

Unit-II

Sr. No.	**Design of Machine Elements**	Lecture required
a	Introduction, shaft, keys and pins	02
b	Couplings, bearing, belt and pulley.	03
c	Chain drive, gear drives, joints, fasteners	02
d	Brackets, gaskets, mechanical seal.	02

Unit – III

Sr. No.	**Design of Pressure Vessels**	Lecture required
a	Introduction, operating condition, uses, codes.	02
b	Selection of material, design conditions and stress.	02
c	Design of shell and its components.	02
d	Design of supports, thermal stress.	02

Unit – IV

Sr. No.	**Design of Heat Exchangers and Evaporators**	Lecture required
a	Introduction, type of heat exchangers, design of shell.	02
b	Design of tube heat exchangers	02
c	Evaporators: - Introduction, types, materials, design considerations.	02
d	Evaporators: - Introduction, types, materials, design considerations	02

Unit – V

Sr. No.	**Process Equipment Design and Standards**	Lecture required
a	Role of process equipment designers, basic process requirements of plants/projects.	02
b	Introduction of design codes and standards IS, ASME, API, BS and its application.	02
c	Plant design management system.	02
d	Plant design management system.	02

Reference Books:

1. Joshi M.V. and Mahajan V.V., "Process Equipment Design", McMillan, India, 1996.
2. Harvey J.F., "Pressure Vessels Design", Van Nostrand Co., 1974.
3. Singh K.P. &Soler A. L., "Mechanical Design of Heat Exchangers ", Arcturus Publishers, New Jersey, 1984.
4. Moss Demis R., "Pressure Vessel Design Manual", Gulf Publishing Co., Houston, 1987.
5. "Handbook of Piping Design", CRC Press, 1992.
6. IS 2825: 1969, Code for Unfired Pressure Vessels.

7. "ASHRAE Handbook : Fundamentals", ASHRAE, 1985. 8. ASME Code, Section 8th, Divison -I, Division-II.

Elective-III
Introduction to Robotics

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Basic Concept In Robotics**	Lecture required
a	Historical perspective of robot, classification of robot, automation and robotics, robot anatomy, basic structure of robotics.	02
b	resolution, accuracy and repeatability, classification and structure of robotics system, point to point and continuous past system.	03
c	control loop of robotics system,	02
d	Robotic application Current and future.	02

Unit-II

Sr. No.	**Mechanical Systems: Components, Dynamics And Modeling**	Lecture required
a	Objectives, Motivation, Review elementary concept	02
b	Motion Conversion, Modeling of Mechanical systems.	03
c	Kinematics chain, Forces encountered in Moving coordinate systems.	02
d	Forces encountered in Moving coordinate systems, Lagrange's Analysis of Manipulator	02

Unit - III

Sr. No.	**Drives And Control System**	Lecture required
a	Hydraulic, DC servomotors, basic control system	02
b	Concept and models, control system analysis.	02
c	Robot activation and feedback component, positional and velocity sensors.	02
d	Actuators, power transmission system, Application of robot in manufacturing.	02

Unit – IV

Sr. No.	**End Effectors, Sensors And Vision Systems**	Lecture required
a	End Effectors Types of end effectors, mechanical grippers	02
b	vacuum, magnetic, adhesive grippers, tools as end effectors, Gripper selection and design	02
c	Introduction to Sensors: Need of sensors in a robotic system, selection of sensors, photo sensors, limit switches.	02
d	Range sensors, proximity sensors, touch / sensors. VISION SYSTEMS: concept of low level and high-level vision in a robotic system.	02

Unit - V

Sr. No.	**Robot Programming**	Lecture required
a	Methods of robot programming, lead through programming methods, a robot program as a path in space.	02
b	Motion interpolation WAIT, SIGNAL, AND DELAY commands.	02
c	ROBOT LANGUAGES: The textural robot languages, generation of robot programming languages	02
d	robot language structure, constant, variables and other. data objects, motion commands, end effector and sensor commands	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Reference Books:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, 2002.
2. Groover," Industrial Robotics", McGraw Hill Publication Co.Ltd.
3. John J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education Inc.,
4. M.P.Groover,"Industrial Robotics - Technology, Programming and Applications". Niku,"Introduction.

Elective-III

Advanced Welding Technology

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Conventional welding Technology**	Lecture required
a	Introduction: Importance and application of welding,	02
b	Classification of welding process. Selection of welding process	02
c	Brief review of conventional welding process: Gas welding, Arc welding, MIG, TIG welding	02
d	Resistance welding. Electro slag welding, Friction welding etc. Welding of MS.CI, Al, and Stainless steel & Maurer/Schaefflar Diagram. Soldering & Brazing.	03

Unit-II

Sr. No.	**Advanced welding Techniques**	Lecture required
a	Principle and working and application of advanced welding techniques	02
b	Plasma Arc welding	02
c	Laser beam welding	02
d	Electron beam welding, Ultrasonic welding etc.	03

Unit - III

Sr. No.	**Advanced welding Techniques**	Lecture required
a	Advanced welding Techniques (continued) : Principle and working a	02
b	application of advanced welding techniques such as explosive welding	02
c	cladding, Underwater welding,	02
d	Spray-welding / Metalizing, Hard facing	02

Unit – IV

Sr. No.	**Metallurgy and Weld Life**	Lecture required
a	Weld Design: Welding machines/equipments and its characteristics and arc-stability, Weld defects and distortion and its remedies, Inspection/testing of welds, Weld Design, Welding of pipe-lines and pressure vessels.	02
b	Life predication. 4 51 Thermal and Metallurgical consideration: Thermal considerations for welding, temperature distribution, Analytical/Empirical analysis/formulae, heating & cooling curves.	02
c	Metallurgical consideration of weld, HAZ and Parent metal	02
d	Micro & macro structure. Solidification of weld and properties.	02

Unit - V

Sr. No.	**Advance welding**	Lecture required
a	Welding Under The Influence Of External Magnetic Field: Parallel Field, Transverse Magnetic Field, Longitudinal Magnetic Field	02
b	Improvement Of Weld Characteristics By The Application Of Magnetic Field, Magnetic Impelled Arc Welding.	02
c	Fundamentals Of Underwater Welding- Art And Science:	02

	Comparison Of Underwater And Normal Air Welding, Welding Procedure,.	
d	Types Of Underwater Welding, Underwater Wet Welding Process Development	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

References,

1. Little R.L., "Welding Technology", Tata McGraw Hill, New Delhi, 1994.
2. Ghosh A. and Mallik A.K., "Manufacturing Science", East West Press, 1985.
3. Davies A.C., "The Science and Practice of Welding", Cambridge University, New York, 1989.
4. Balchin N.C., "Health and Safety in Welding and Allied Processes", Jaico Publishing House, Mumbai, 1989.
5. Rao P. N., "Manufacturing Technology", Tata McGraw Hill, 1990.
6. Mukharjee P. C., "Fundamental of Metal Casting Technology", Tata McGrew Hill, 1970.
7. Jeffus Larry “Welding Principles and Applications” Delmar Publishers, 1999.

Elective-III

Energy Conservation and Management

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Energy Scenario**	Lecture required
a	Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario.	03
b	2Sectoral energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing.	03
c	Energy security, energy conservation and its importance, energy strategy for the future, Energy Conservation Act 2001 and its features.	03

Unit-II

Sr. No.	**Basics of Energy its various forms and conservation**	Lecture required
a	Electricity basics – Direct Current and Alternative Currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature and pressure	03
b	Heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity and heat transfer.	03
c	Evaluation of thermal performance – calculation of heat loss – heat gain, estimation of annual heating & cooling loads, factors that influence thermal performance, analysis of existing buildings setting up an energy management programme and use management – electricity saving techniques.	03

Unit - III

Sr. No.	**Energy Management & Audit**	Lecture required
a	Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs.	02
b	Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution.	02
c	Financial Management: Investment-need, appraisal and criteria, financial analysis techniques-simple payback period, return on investment, net present value,	02
d	Internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs).	02

Unit – IV

Sr. No.	**Energy Monitoring and Measurement**	Lecture required
a	Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption	02
b	Production, cumulative sum of differences (CUSUM). Energy	02

	Management Information Systems (EMIS)	
c	Basic measurements – Electrical measurements, Light, Pressure, Temperature and heat flux, Velocity and Flow rate, Vibrations, etc.	02
d	Instruments Used in Energy systems: Load and power factor measuring equipments, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis etc. Mathematical and statistical modelling and analysis.	02

Unit - V

Sr. No.	**Energy Efficiency in Thermal Utilities and systems**	Lecture required
a	Energy efficiency in thermal utilities like boilers, furnaces, pumps and fans , compressors, cogeneration (steam and gas turbines)	02
b	Heat exchangers, lighting system, Motors belts and drives, refrigeration system.	02
c	Heat recovery from ventilation	02
d	Air co-generation of heat and electricity, heat recovery and bottoming cycles.	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Reference Books:

1. Energy Engineering and Management AmlanChakrabarti Prentice hall India 2011
2. Energy Management Principles, CB Smith, Pergamon Press, New York,
3. Bureau of energy efficiency –Hand outs New Delhi .
4. Energy Management Hand Book. W. C. Turner.John Wiley and sons
5. Handbook on Energy Efficiency, TERI, New Delhi, 2009
6. Energy Auditing and Conservation; Methods, Measurements, Management & Case Study, Hamies, Hemisphere Publishing , Washington, 1980.
7. Industrial Energy Management & Utilization, Write, Larry C Hemisphere Publishers, Washington, 1998.Energy Conservation In Process Industry, W. F. Kenny

Elective-III

Automobile Engineering – II

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Automobile Brakes**	Lecture required
a	Introduction, Braking Requirements, Function of the brakes, Classification of the brakes	1
b	Hydraulic Brakes, Power Brakes	2
c	Air Brakes, Brake Efficiency & Stopping Distance	2
d	Factor Controlling the Stop of an Automobile	2
e	Brake Lining, Brake Testing & Testers, Brake Service	2
Guidelines for the examiners and paper setters: Question should not be asked from introductory part of syllabus.		

Unit-II

Sr. No.	**Automobile Electrical System**	Lecture required
a	Introduction to Starting System, Lead-Acid Battery, Recharging of Battery, Charging procedure	2
b	Battery voltage, Battery Capacity, Battery Rating, Battery Life,	1
c	Factors affecting Battery life, Battery testing, Battery troubles	1
d	Introduction to Ignition System-Types, Introduction Charging System, Spark Plug	2
e	Introduction To Wiring System, Standard Color coding, Tracking faults in wiring,	1
f	Functioning of the Electrical system in an Automobile, Improvement in Electrical system in an Automobile	2
Guidelines for the examiner and paper setter. Question should not be asked from introductory part of syllabus.		

Unit - III

Sr. No.	**Automobile Heating, Ventilation and Air Conditioning**	Lecture required
a	Nature of Heat, Heating System, Air Conditioning System and its Operational Principle	2
b	Air Conditioning System and its Operational Principle, Air Conditioning Components, Effect of Air Conditioning on Fuel Economy	2
c	Air Conditioning System Refrigerant, Conventional Heating and Ventilation	1
d	Air Distribution Parts, Automatic Climate Control	1
e	Automatic Temperature Control System, Air Conditioning Troubleshooting, Heating System Troubleshooting	2
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus.		

Unit – IV

Sr. No.	**Alternative Fuelled Automobiles**	Lecture required
a	Introduction, Battery of Electrical Vehicle(EV), Fuel Cell-as a Source of Energy, Solar Powered Automobiles	2
b	Hybrid Drives, Drive Motors	1
c	Compressed Natural Gas (CNG) Operated Automobiles, Liquefied Petroleum Gas (LPG) as a Substitute Fuel	2
d	Future Alternative Fuels for IC Engine, Particular tips for getting more Mileage	1
e	How to Save Fuel, Biodiesel- Another substitute for existing fuel, Future Trends in Automobile Development	2
Guidelines for the examiners and paper setters: Question should not be asked from introductory part of syllabus.		

Unit - V

Sr. No.	**Automobile Emissions and its Control**	Lecture required
a	Introduction, Air Pollution- Environment & Health Impacts, Major Pollutants and their Sources of Emission	1
b	Pollutants and Mechanism of their Formation, Mechanism of Pollutants Formation in SI Engine	1
c	Smoke, Causes of Smoke, Factor Affecting Diesel Smoke	1
d	Comparison of Diesel & Gasoline Engine emission, Harmful Effects of Different Pollutants, Emission Control System	2
e	Regulation and Norms on Exhaust Emission	1
	Introduction to Green House Effect and Global Warming, Noise Pollution and its Control, EURO & Indian Emission Standards	2
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

References Book:

1. Automobile Engineering Vol. 1 & 2 by Dr. Kripal Singh, (Standard Publishers Distributors)
2. A textbook of Automobile Engineering I & II by P. S. Gill, (S. K. Kataria& Son's)
3. Automobile Engineering by R. B. Gupta, (SatyaPrakashan)
4. Automobile Engineering by Dr. V. M. Domkundwar, (DhanpatRai& Company)
5. A textbook of Automobile Engineering by R. K. Rajput, (Laxmi Publication Pvt. Ltd.)
6. Automobile Engineering by K. M. Moeed, (S. K. Kataria& Son's)
7. Automobile Engineering by Dr. A. K. Basu, (S. Chand Company Pvt.

Elective-III

Thermal Equipment design

Teachers, Paper setters and Examiners should follow the guidelines as given below.

Unit-I

Sr. No	**Magnetically Coupled Circuits And Transformer:**	Lecture required
a	Introduction to engineering design, Decision in an Engineering undertaking, Design Vs Analysis, Synthesis for Design, Selection Vs Design.	01
b	Designing a workable system: workable system design and analysis, creativity in concept selection, workable Vs. optimum system,	01
c	Economics: Interest, Lump sum compounded annually and more than annually, compound amount factor, present worth factor, future and uniform series amount, Gradient factor, Shift in time, Taxes , Depreciation	02
d	Decision making to design a food freezing plant	02
e	Decision making to optimize thickness of insulation in refrigerated ware house	02
f	Decision making to optimize of natural convection air cooled condenser	01

Unit-II

Sr. No.	**Modeling of thermal equipments and simulation**	Lecture required
a	Matrices, Solution of simultaneous equation, Polynomial presentation (polynomial, one variable a function of other variable and n+1 data points), simplification.	02
b	Method of Least square, the art of equation fitting,	02
c	Selecting Vs simulating, (Heat exchanger), System simulation, Information flow diagrams, Successive substitution method, pitfalls in successive substitution method	03
d	Newton Raphson method for multivariable and convergence characteristics, Compare successive substitution method and Newton Raphson method	02

Unit - III

Sr. No.	**Optimization**	Lecture required
a	Introduction, levels of optimization, Mathematical representation of optimization problem	02
b	Setting up the mathematical statement of optimization problems, Properties of objective function, Unconstrained optimization and Constrained optimization problem	02
c	Mathematical proof of Lagrange multiplier method, Test of Maxima and minima, Kunhn- tuker conditions, Unimodal function and search method	02
d	(Only basic introduction to all methods no numerical will be asked)Dichotomous search, Fibonacci search method, Introduction to multivariable optimization, Multivariable optimization, Conjugate gradient method	02

Unit – IV

Sr. No.	**Mathematical Modelling- Thermodynamic properties**	Lecture required
a	Introduction, Criteria for fidelity of representation,Linear and non linear regression analysis.	02
b	Thermodynamic properties,Internal energy,enthalpy,clayperon equation,P-T relation at saturated condition, specific heats, Maxwell relation.	02
c	P-V-T equation (Vander walls equation),Building and full set of data.	02
d	Introduction to steady state simulation, convergence and divergence in successive substitution,partial substitution in successive substitution, Evaluation of Newton Rapson Technique and characteristics for heat exchanger.	02

Unit - V

Sr. No.	**Dynamic behavior of thermal system**	Lecture required
a	Introduction,Significance,Scope,Approach,One dynamic element in stead state simulation for refrigeration plant etc. (Heat exchanger)	02
b	Laplace Transform and Inverse of Laplace transforms,Blocks,Block Diagram and Transfer function,Feed control loop, Time constant block (Consider Temperature sensing bulb in a fluid duct)	02
c	Stability analysis,Normalizing the variable for Inversion to the time (Take the case to regulate the air pressure in a reservoir)	02
d	Translating the physical situation in block diagram (take example for air heating system and its control), non-linearity's	02
Guidelines for the examiner and paper setter. Questions should not be asked on introductory part of syllabus		

Reference Books:

1. J.P. Holman 1992 "Heat Transfer" McGraw Hill VII Edition.
2. P. Kothandaraman "Fundamentals of Heat and Mass Transfer".
3. D.S. Kumar "Heat and Mass Transfer" D.S. Kumar S.K. Kataria& Sons, Delhi.
4. P.K. Nag "Heat Transfer" Tata McGraw Hill Publishing Company Ltd., New Delhi.
5. Thermal Design and Optimization, Adrian Bejan, George Tsatsaronis, Michael J. MoranJohn Wiley & Sons, 1996.
6. Design and Optimization of Thermal Systems, Second Edition (Mechanical Engineering)byYogeshJaluria.
7. Design of thermal systems, W.F.Stoecker, McGraw hill Book Company.

Mechanical Vibration

(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	To study the torsional vibrations of single rotor system.	02
2	To study the torsional vibrations of two rotor system.	02
3	To study damped torsional vibrations of single rotor system.	02
4	To study undamped free vibrations of a spring.	02
5	To study the natural vibrations of a spring mass system.	02
6	To study forced damped vibrations of a spring mass system.	02
7	To study the forced damped vibrations of simply supported beam.	02
8	To determine critical speed of a single rotor system.	02

Note: Lab file should contain at list five experiments from above mentioned list.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-

In ESE the student may be asked questions on the prescribed certified journal Evaluation will be based on oral examination.

Finite Element Analysis and Simulation Techniques
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	Analysis of I-cantilever beam.	02
2	Analyzing Flow in a System of Pipes	02
3	Analysis of Trusses.	02
4	Modal Analysis of Spring-Mass System.	02
5	Modal Analysis of continuous System.	02
6	Thermal analysis of any component.	02
7	Stress strain analysis of any component.	02
8	Kinematic Analysis and simulation of slider crank Mechanism	02

Note: Lab file should contain any **five** experiments by using any design software.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-

In ESE the student may be asked to perform any one practical. Evaluation will be based on paper work , practical performance and oral in the practical examination.

Elective -II
Tribology
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	Practical on Journal Bearing apparatus.	02
2	Practical on Tilting pad thrust bearing apparatus	02
3	Friction in Journal Bearing	02
4	Practical on Brake line friction test rig.	02
5	Practical using Pin on disc test rig.	02
Any 03experiments should be perform from above list and 03assignment include in the course based on curriculum of this course		

Note: Any 03experiments should be performing from above list and 03assignment include in the course based on curriculum of this course.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-

In ESE the student may be asked questions on the prescribed certified journal Evaluation will be

based on oral examination.

Elective –II
Power Plant Engineering
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	Study of Fluidized Bed Combustor	02
2	Study of Environmental Impact of Thermal Power Plant.	02
3	Study of Demand supply scenario of Electricity.	02
4	Study or visit of Co-generation Plant.	02
5	Study or visit of Non conventional power plant.	02
6	Efficiency measurement of Standalone Solar PV System.	02
7	Measurement of current-voltage characteristics of two solar cells connected a) in series and b) in parallel.	02
Any six activities to be performed from above list. The Oral Examination will be based on the all five units of Power Plant Engineering.		

Note: Lab file should consist of any six experiments to be performed from above list.

Guide lines for ICA:

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-

In ESE the student may be asked questions on practical. Evaluation will be based on answers given by students in oral examination.

Elective -II
Process Equipment Design
(Lab Course Contents)

Teacher should facilitate learning following lab experiments:

S.N.	Lab Experiment	Hours required
1	Design and drawing of pressure vessels.	02
2	Design and drawing of storage vessels.	02
3	Assignment on safety measure in process equipment design.	02
4	Study of pressure relief devices.	02
5	Study of vessels under external pressure.	02
6	Study of design codes and standards.	02

Note: Lab file should consist of minimum **five experiments**.

Guide lines for ICA :

ICA shall be based on continuous evaluation of student performance throughout semester and practical assignment submitted by the student in the form of journal.

Guide lines for ESE:-

In ESE the student may be asked questions on practical. Evaluation will be based on answers given by students in oral examination.

Industrial Lecture
(Course Contents)

1	There is a need to create avenues for a close academia and industry interaction through all the phases of technology development, starting from conceptualization down to commercialization.
2	Minimum 6 lectures to be delivered by experts from the industry in alternate weeks. Next week group discussion on the lecture delivered.
3	Student should submit assignment in hard copy on the topic of industry lecture. The number of assignment should be equal to number of industry lecture.

ASSESSMENT OF Industrial Lecture

Guide lines for ICA: Assessment of the Industrial Lecture for award of ICA marks shall be done jointly by departmental committee as per attendance in industrial lecture, report submitted by student and overall performance in semester as per the guidelines given in **Table- D**

Table-D

SN	Name of Student	Attendance (05 Marks per Lecture)	Dept of Understanding (03 Marks per Lecture)	Report Writing	Total
		25	**15**	**10**	**50**

Project-II

(Lab Course Contents)

1	Every student of Final year shall undertake the Project-II in semester VIII.
2	Each student shall work on an approved project, a group of **05 students (maximum)** shall be allotted for the each Project-II as same group for Project-I.
3	Project-II may involve fabrication, design or investigation of a technical problem that may take design, experimental or analytical character or combine element of these areas. The project work shall involve sufficient work so that students get acquainted with different aspects of fabrication, design or analysis, testing, their result and conclusion.
4	Each student group is required to maintain log book for documenting various activities of Project-II.and submit group project report at the end of Semester-VIII.

Guide lines for ICA: ICA shall be based on continuous evaluation of students' performance throughout semester in project-II and report submitted by the students' project group in the form hard bound. Assessment of the project-II for award of ICA marks shall be done jointly by the guide and departmental committee as per the guidelines given in **Table-E.**

Guide lines for ESE:-

In ESE the student may be asked for demonstration and questions on Project. Evaluation will be based on answers given by students in oral examination.

Assessment of Project-II

Name of the Project: _____

Name of the Guide: _____

Table-E

		Assessment by Guide (50 Marks)				**Assessment by Committee (25 Marks)**		
SN	**Name of Student**	**Attendance, Participation and team work**	**Material procurement / assembling/ Designing/Programming**	**Case study/ Execution**	**Project Report**	**Dept of Understanding**	**Presentation**	**Total**
Marks		**10**	**15**	**15**	**10**	**10**	**15**	**75**