

COURSE: B.E. (MECHANICAL ENGINEERING)

SEMESTER: VI

Sr. No	Subjects	No. of periods of 1Hour			Duration of Theory Paper in Hours	Marks				
		Lecture	Practical	Tutorial		Theory Paper	Term Work	Practical	Oral	Total
1	Mechatronics*	4	2	--	3+2PE	100	25	25	--	150
2	Hydraulic Machinery	4	2	--	3	100	25	--	--	125
3	Mechanical Vibrations*	4	2	--	3	100	25	--	25	150
4	E-Commerce and Industrial Finance	4	--	01	3	100	25	--	--	125
5	Internal Combustion Engine*	4	2	--	3+2PE	100	25	25	--	150
6	Machine Design- I *	4	2	--	4	100	25	--	25	150
TOTAL		24	10	01	--	600	150	50	50	850

*Common with Automobile engineering.
 (PE) - Practical Examination Environmental Studies*

CLASS: T.E. (Mechanical/Automobile)		Semester:- VI	
MECHATRONICS			
Periods per week 1Period of 60 min.	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory Examination	04	100
	Practical	--	25
	Oral Examination	--	-----
	Term Work	--	25
	TOTAL		150

Sr. No.	Details	Hrs.
Module 01	Introduction to Mechatronics, Mechatronics Systems in Factory, Home and Business Applications, Basic Components of Mechatronic Systems, Mechatronics Design process, Objectives, Advantages and Disadvantages of Mechatronics.	02
Module 02	Overview of micro processors and micro-controllers. 8051 microcontrollers: Functional block diagram and architecture, Instruction set and assembly language programming. Interfacing of: HEX-keyboards, LCD display, ADC, DAC and stepper motor	14
Module 03	<u>(a) Pneumatic and Hydraulic actuation systems:</u> Pneumatic and hydraulic systems. Electro-Pneumatic systems Electro-Hydraulic systems. Development of circuits for Industrial Automation. <u>(b)PLC in Automation:</u> Basic structure, I/O processing, Ladder logic diagram, Selection of PLC.	14
Module 04	Introduction to control systems, open loop and closed loop systems, Mathematical modeling of control systems, concept of transfer function, Block diagram algebra, State space modeling, Process control systems, ON-OFF control, P-I-D Control. Control system components: servomotor, stepper motors.	08
Module 05	Transient Response Analysis of First and Second order system, Time domain specifications. Step response of second order system. Classification of control systems according to 'TYPE' of systems, steady-state errors, static error constants, steady state analysis of different type of systems using step, ramp and parabolic inputs.. Stability analysis: Introduction to concepts of stability, The Routh and Hurwitz stability criteria, Relative stability analysis.	08
Module 06	Root locus concepts. Frequency Response Analysis: Frequency domain specifications, Correlation between time and frequency response, Polar Plots, Bode Plots, Nyquist Plots,	08

List of Experiments:

(At least 6 experiments from the list given below)

1. Study of basic principles of sensing and actuation techniques used in Mechatronics systems
2. Study of Electro-pneumatic Logic Trainer kit, and experiments on Electro-pneumatic circuits
3. Study of Electro-hydraulic Logic Trainer kit, and experiments on Electro-hydraulic circuits
4. Experiments on Ladder programming for Mechatronics system (e.g. bottle filling plant)
5. Experiments on interfacing of Mechanical system
6. Experiments on feedback control systems and servomechanisms
7. Experiments using Microprocessor kits, ADC/DAC on voltage Measurements.
8. Experimental Identification by frequency response approach of Mechanical, Electrical, Chemical system
9. Experimental Identification of flexural mechanism, Development of transfer function based on experimentally identified data, Stability analysis of predicted transfer function, and PID tuning and implementation on experimental setup
10. Experiment based on Waveform generation, Interfacing and control of motors etc.

(Institutes shall use standard setup like VIKERS hydraulic and electrohydraulic test rigs , FESTO pneumatic and electro-pneumatic test-rig, d space microcontroller system etc. for carrying out experiments)

Theory Examination:

1. Question paper will comprise of total seven question, each of 20 Marks
2. Question one will be compulsory and based on maximum part of syllabus.
3. Remaining questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only five question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Practical Examination:

Practical examination will be based on one experiment performed from the list of experiment given in the syllabus.

Course Project

In course project students shall integrate and apply the knowledge gained during the course. The projects will be developed by teams of maximum four students and shall consist of the design, setup and implementation of a simple mechatronics system.

Term Work:

Term work shall consist of minimum 06 experiments, assignments and written test. The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/assignments/Course project):(15) Marks.
- Test (at least one): (10) Marks.
- TOTAL: (25) Marks.**

Text Books:

1. Mechatronics, Kenji Uchino and Jayne R. Giniewicz, publication: Marcel Dekker, Inc.
2. Mechatronics System Design , Shetty and Kolk *CENGAGE Learning, India Edition*
3. Design with Microprocessors for Mechanical Engineers, Stiffler *McGraw-Hill*

4. Introduction to Mechatronics and Measurement Systems , Alciatore and Histan *Tata McGraw-Hill*
5. Mechatronics, Neculescu, *Pearson education*.
6. Mechatronics - Electromechanics and Control Mechanics , Mill *Springer-Verlag*
7. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton *Pearson education*
8. Mechatronics - Electronics in products and processes , Bradley, et al. *Chapman and Hall*
9. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, *Prentice Hall*
10. Introduction to Mechatronics, Appu Kuttan K.K., *OXFORD Higher Education*
11. Applied Mechatronics- A. Smaili and F. Mrad, *OXFORD university press*.
12. Microprocessor Architecture, Programming and Applications with 8085, Gaonkar. R.S., *Wiley Eastern Limited*.
13. Pneumatic Circuits and Low Cost Automation: by Fawcett J.R.
14. Control System Engineering: by Nagrath IJ. and Gopal .M., *Wiley Eastern Ltd*.
15. Modern Control engineering: by K.Ogata, *Prentice Hall*
16. The 8051 microcontroller Architecture, Programming and Applications by Kenneth J TAYala, Penram International Publishing, (India).

References:

1. The Art of Electronics, Horowitz and Hill Cambridge, *University Press*
2. The 8051 microcontroller and embedded systems using assembly and C by M.A.Mazidi, J. C. Mazidi and R. D. McKinlay, PHI, second edition
3. Electromechanical Design Handbook , Walsh, *McGraw-Hill*
4. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
5. Handbook of Electromechanical Product Design , Hurricks Longman, John Wiley, *Addison Wesley*
6. Principles and Applications of Electrical Engineering , Rizzoni *Irwin Publishing*
7. Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics , Kamm *IEEE*
8. Modeling and control of Dynamic Systems, Macia and Thaler, *CENGAGE Learning, India Edition*
9. Mechatronics, A.Smaili, F.Mrad, *OXFORD Higher Education*.
10. Pneumatic and Hydraulic Control Systems: Aizerman. M.A.
11. Industrial Hydraulics: Pippenger
12. Vickers Manual on Hydraulics
13. Computer Numerical Control of Machine Tools: Thyer. G.R.
14. Pneumatic Applications: Deppert Warner & Stoll Kurt
15. Mechanization by Pneumatic Control: Vol. 1 & 2 Deppert Warner & Stoll kurt
16. Hydraulics and Pneumatics for Production: Stewart
17. Hydraulic Valves and Controls: Pippenger
18. Automatic Control Engineering: Francis. H. Raven.
19. Mechatronics, Nitaigour Mahalik, *Tata McGraw-Hill*
20. Mechatronics, *HMT*
21. *System Identification*: Theory for the User (2nd Edition) , Lennart Ljung
22. Fundamentals of Pneumatics: Festo Series
23. Fundamentals of Electro-Pneumatics :Festo Series
24. Fundamentals of Hydraulics: Festo Series
25. Fundamentals of Electro-Hydraulics: Festo Series

CLASS: TE (Mechanical)		Semester:-VI	
SUBJECT: HYDRAULIC MACHINERY			
Periods per week 1 Period of 60 min.	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical	--	--
	Oral Examination		--
	Term Work		25
	TOTAL		125

Sr. No.	Details	Hrs.
Module 01	<p>Hydro Turbines:</p> <p>1.1 General: Advantages of a hydro power plant over other types of power plants, Elements of a hydro power plant, types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done.</p> <p>1.2 Pelton Turbines: Components of a Pelton turbine, definition of design parameters like speed ratio, jet ratio, estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets.</p>	8
Module 02	<p>2.1 Reaction Turbines: Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters.</p>	9
Module 03	<p>3.1 Similarity relations in turbines, definition of unit quantities and specific quantities, selection of turbines. Prediction of results of prototypes from the model test.</p> <p>3.2 Cavitation in turbines - causes, effects and remedies, Thoma's cavitation parameter σ. Use of σ Vs specific speed graphs. Determination of safe height of installation for the turbine.</p> <p>3.3 Characteristics of turbines, governing of turbines.</p>	7
Module 04	<p>Pumps:</p> <p>4.1 General: Classification of pumps - positive displacement and non - positive displacement.</p> <p>4.2 Positive - Displacement pumps: Types and applications, general features of rotary pumps like gear pumps, vane pumps etc., general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel.</p>	8

Module 05	5.1 Centrifugal Pump: Types - radial flow , mixed flow and axial flow, Priming of pumps, components of the pump, Euler's equation and velocity triangles, correction factors for the head, design constant eg., head constant, flow constant etc., 5.2 Types of blade profiles, aerofoil theory of axial flow pumps 5.3 Pressure recuperating devices, Radial thrust and axial thrust and methods used to balance them. 5.4 Trouble shooting in centrifugal pumps, self priming pumps.	9
Module 06	6.1 Concept of system and system characteristics, priming of pumps. 6.2 Series and parallel operation of pumps. System curve for branch network. Determination of operating point. 6.3 Similarity relations and affinity laws, characteristics of pumps. 6.4 Cavitation and NPSH (NPSHA, NPSHR), Determination of available and required NPSH 6.5 Case studies using CFD (exclusively on Hydraulic Machinery).	7

List of Experiments:

(At least six experiment from the list)

1. Variable speed and constant speed characteristics of Pelton turbines.
2. Variable speed and constant speed characteristics of Francis turbines.
3. Variable speed and constant speed characteristics of Kaplan turbines.
4. Variable speed and constant speed characteristics of centrifugal pumps - plotting of Muschel curves.
5. Characteristics of reciprocating pumps, gear pump etc.
6. Series and parallel operation of pumps.
7. NPSH characteristics of pumps.
8. Characteristics of self-priming pumps.

Educational Visit:

Organize at least one visit to hydro power station. Student shall submit a brief technical report of the visit as a part of term work.

Theory Examination:

1. Question paper will comprise of total seven question, each of 20 Marks
2. Question one will be compulsory and based on maximum part of syllabus.
3. Remaining questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only five question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Term Work:

Term work shall consist of minimum **06** experiments, assignments (at least one on each module), brief report of educational visit and written test. The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/assignments, report): ... (15) Marks.
- Test (at least one): (10) Marks.
- TOTAL: (25) Marks.**

Text Books:

1. Hydraulic Machinery - Jagdish Lal
2. Hydraulic Machines - Vasandani
3. Centrifugal pumps and blowers - Church and Jagdish Lal
4. Fluid Mechanics and Machinery—B C S Rao, *McGraw Hill*
5. Fluid Mechanics and Hydraulic Machines—Gupta, *Pearson Education*
6. Fluid Mechanics – Douglas 5th ed, *Pearson Education*

References:

References:

1. Impeller pumps - Trokolansky and Lazerkiewicz
2. Centrifugal and axial flow pumps - A. J. Stepanoff
3. Pump Handbook - Karassik et al.
4. Hydraulic Turbines – Nechleba

CLASS: TE (Mechanical/Automobile)		Semester:-VI	
SUBJECT: MECHANICAL VIBRATION			
Periods per week. 1 Period of 60 min.	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical	--	--
	Oral Examination	--	25
	Term Work	--	25
	TOTAL	--	150

Sr. No.	Details	Hrs.
Module 01	<p>1.1 Basic Concepts Of Vibration: Vibration and oscillation, causes and effects of vibrations, Vibration parameters - spring, mass, damper, Damper models, Motion - periodic, non periodic, harmonic, non - harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis.</p> <p>1.2 Free Undamped Single Degree Of Freedom Vibration System: Longitudinal, transverse, tensioned system, Methods for formulation of differential equations' by Newton, Energy, Lagrangian (Rayleigh's method), Effect of springs mass and shaft inertia on natural frequency, Effect of flexible bearings on natural frequency.</p>	8
Module 02	<p>2.1 Free Damped Single Degree Of Freedom Vibration System: Viscous damped system - under damped, critically damped, over damped Logarithmic decrement. Coulomb's damping Combined viscous and coulomb's damping</p> <p>2.2 Equivalent Single Degree Of Freedom Vibration System: Conversion of multi-springs, multi masses, multi - dampers into a single spring and damper with linear or rotational co-ordinate system</p>	8
Module 03	<p>3.1 Free Undamped Multi Degree Of Freedom Vibration Systems: Eigen values and Eigen vectors for linear system and torsional two degree of freedom Holzer method for linear and torsional unbranched system Two rotors, Three rotors and geared system. Dunkerley and Rayleigh method for transverse vibratory system</p> <p>3.2 Forced Single Degree Of Freedom Vibratory System: Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper)</p>	8
Module 04	<p>4.1 Vibration Measuring Instruments: Principle of seismic instruments, vibrometer, accelerometer - undamped, damped.</p> <p>4.2 Vibration Isolation: Force isolation, motion isolation, isolators</p>	8

Module 05	5.1 Rotor Dynamics: Critical speed of single rotor, undamped and damped 5.2 Cam Dynamics: Cam Dynamics: Mathematical Model, Differential Equation, Response Follower Jump Phenomenon	8
Module 06	6. Balancing: Static and dynamic balancing of multi rotor system, Balancing of reciprocating masses In - line engines, V - engines (excluding radial engines)	8

List of Experiments: (Minimum 8 experiments)

1. Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system.
2. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel
3. Experimental prediction of natural frequencies, and nodal points for single-rotor and two-rotor vibratory system, and comparison with theoretical results
4. Experimental and theoretical investigation of whirling of shaft (i.e. comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory)
5. Experimental investigation of viscous and coulomb damping, prediction of system parameters (spring stiffness, damping coefficient) from damped oscillations
6. Experimental and theoretical investigation of frequency response of mechanical system, and comparing both and justification of discrepancy between theory and experiments
7. Experiments on distributed parameter system: Transverse vibrations of beam (Dunkerley's Rule Expt.)
8. Experimental balancing of single and multi-rotor system
9. Introduction to FFT analyzer, and prediction of spectral response of vibrating machine from workshop
10. Experiments on vibration isolation system and prediction of force transmissibility, motion transmissibility of system
11. Vibration analysis of mechanical system using MATLAB.

Theory Examination:

1. Question paper will comprise of total seven question, each of 20 Marks
2. Question one will be compulsory and based on maximum part of syllabus.
3. Remaining questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only five question need to be solved.
- 5.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral examination will be on maximum portion of syllabus.

Term Work:

Term work shall consist of minimum **08** experiments, assignments and written test. The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/assignments): (15) Marks.
- Test (at least one): (10) Marks.
- TOTAL:** (25) Marks.

Text Books:

1. Mechanical Vibrations 4th ed- S. S. Rao – *Pearson Education*
2. Mechanical Vibrations - G. K. Grover
3. Fundamentals of Mechanical Vibration – S.Graham Kelly - *Tata McGraw Hill*
4. Mechanical Vibration Analysis - P. Srinivasan - *Tata McGraw Hill*
5. Mechanical Vibrations - Schaum's outline series - S.Graham Kelly- *McGraw Hill*
6. Mechanical Vibrations - Schaum's outline series – William W. Seto- *McGraw Hill*
7. Theory and Practice of mechanical vibrations - J. S. Rao, K. Gupta - *New Age International Publications*.
8. Mechanical Vibrations - Den, Chambil, Hinckle
9. Mechanical Vibrations, J.P.Den Hartog, *McGrawhill Book Company Inc.*

References:

1. Leonard Meirovitch, Introduction to Dynamics and Control. *Wiley, New York*,
2. Leonard Meirovitch, Elements of Vibration Analysis. *McGraw-Hill, New York*,
3. Leonard Meirovitch, Dynamics and Control of Structures. *Wiley, New York*.
4. Antony J. Pettofrezzo, Matrices and Transformations. *Dover, New York*.
5. Benson H. Tongue, Principles of Vibration. *Oxford University Press*.
6. W. Thomson, Theory of Vibrations With Applications, Second Edition, *Pearson Education*
7. Vibrations—Balakumar Balachandan, Edward Magrab, *CENGAGAE Learning*.

CLASS: TE (Mechanical)		Semester:-VI	
SUBJECT: E-COMMERCE AND INDUSTRIAL FINANCE			
Periods per week. 1 Period of 60 min.	Lecture	04	
	Practical	--	
	Tutorial	01	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical	--	--
	Oral Examination		--
	Term Work		25
	TOTAL		125

Sr. No.	Details	Hrs.
	E-COMMERCE	
Module 01	1.1 Introduction: Understanding E-Commerce, Emergence of the internet. Emergence of the worldwide web. Advantage and disadvantages of E- Commerce, E-Commerce in action, Reality and myth.	06
	1.2 Enabling Technologies Of E- Commerce : Internet client/server application, Networks and internets, Software agents, Internet standards and specifications, Internet service providers, Staffing for E-Commerce.	

Module 02	2. E-Commerce Business Solutions : E- Marketing ; Online marketing, advantages of online marketing, E- advertising : various means , Efficiency of E- Advertising , E- branding , Marketing strategies , E-Security , Security on Net, E- business Risk management issues, E-Payment systems, Online payment categories, Digital token based E-Payment systems, Risk and E-Payment systems, Designing E- Payment Systems. E- Customer relationship management, E- CRM solutions, E-CRM toolkit, CRM capabilities and the customer life cycle. E-Supply Chain Management. Strategic advantages and benefits , Components and architectures , Major trends in E-SCM, E- strategy server dimensions, value chain and E- strategy, Planning the E-Commerce project, Brand management strategies.	08
	3. Transition To E-Commerce In India : E-transition challenges to Indian corporate, The information technology Act 2000, Positive aspects for corporate sector, Some Indian case studies, E- Commerce best practices, Modern trends in E-Business.	
Module 03		07

INDUSTRIAL FINANCING		
Module 04	<p>4.1 The Scope Of Industrial Finance : Introduction, Finance defined, Microfinance v/s Macrofinance, Corporate finance and other disciplines, The financial manager, The goal of corporate finance, profit maximization and traditional goal, Improving open tradition through value maximization.</p> <p>4.2 Financial Markets The other form of organization Capital, cash money and Govt. securities, Financial market overview, How new securities are issued, Public issue: General cash offer, Public issue: Rights offering, Private placement. Types of financial markets The common stock market, the bond market, The money market, International financial market, Efficiency of financial market, interest rates, the term structure of interest rates, The risk structures of interest rates.</p>	09
Module 05	<p>5.1 An Overview Of Investment Appraisal Methods : Time value of money, The accounting rate of return method , The net present value method , The internal rate of return method , a comparison of NPV and RR method, Discounted payback method, Annual capital charge.</p> <p>5.2 Sources Of Long Term Finance : Equity finance , The new issues market , Right issues , Script issues , Preference shares , DEBT finance , Hybrid finance , Sources of intermediate term finance, term loans and leases , Short term financial markets , Managing corporate liquidity , The concept of circulating resources , The impact on risk and return , Managing current assets , Manage financial structure.</p> <p>5.3 Working Capital Management : Objectives, Working capital policies, Working capital and cash conversion cycle, Overtrading, The management of stock, Management of costs.</p>	10
Module 06	<p>6.1 Mergers And Takeovers : Terminology, Justification for acquisition, Trends in takeover activities, Valuation of the target company, The financing of acquisition, Strategies and tactical issues.</p> <p>6.2 International Financial Management : Exchange rates, Fixed verses floating exchange rates, Spot rates, forward rates, Future rates, Factor affecting exchange rates, Foreign exchange exposure managing foreign exchange, Exposure Recent trends.</p>	08

Theory Examination:

1. Question paper will comprise of total seven question, each of 20 Marks
2. Question one will be compulsory and based on maximum part of syllabus.
3. Remaining questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only five question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Term Work:

At least six assignments / problems on concepts, Case studies and analysis based on the topics mentioned above and written test. The distribution of marks for term work shall be as follows:

• Assignments work and case studies:	(15)	Marks.
• Test (at least one):	(10)	Marks.
TOTAL:	(25)	Marks.

Text Books:

1. E- Commerce A management perspective P.T.Joseph , *Prentive Hall of India Pvt. Ltd.*
2. E- Commerce strategies Charles Trepper, *Prentive Hall of India Pvt. Ltd.*
3. E- Business and ERP , Transforminf the Enterprise Grant Morris , James R. Hurley, John Willey & Sons. Inc.
4. Fundamentals of Financial Management, Prasanna Chandra , 4th Edition , *Tata Mcgraw Hill Publishing Company Ltd.*
5. Introduction to Corporate finance Terry's Maness , *Mc Graw Hill series in Finance*

References:

1. Corporate Finance Principles And Practises, Denzil Watson & Tong Heads , Financial Time Pitman Publisher
2. Handbook Of Corporate Finance, Edward I. Altmass , Willy Professional Banking & Finance Services
3. Introduction to Financial Management, Bidil Dickerson , Eudere F. B. , *The Dryden Press*
4. E- Commerce Kenneth C. laudon, Carol G. Traver Pearson Education

CLASS: TE (Mechanical/Automobile)		Semester:-VI	
SUBJECT: INTERNAL COMBUSTION ENGINES			
Periods per week. 1 Period of 60 min.	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical	02 (PE)	25
	Oral Examination	--	--
	Term Work	--	25
	TOTAL	--	150

Sr. No.	Details	Hrs.
Module 01	1. Constructional Features of Reciprocating I.C. Engines: 1.1. Four stroke and two stroke engines. 1.2. Types of engines - Stationary, Automotive, and Marine engines. 1.3. Comparative study of Two stroke and Four stroke engines. Different methods of Scavenging and scavenging blowers. 1.4 Cycle Analysis of I.C. Engines: 1.5 Variable specific heat and its effect on Air Standard Cycles, Fuel Air Cycles. Dissociation and other losses. Actual cycles.	06
Module 02	2.1. Carburetion - Theory of Carburetion, Simple carburetor, various systems of actual Carburetor, Types of Carburetors. 2.2. Ignition System - Battery and Magnetic Ignition Systems. Electronic Ignition System 2.3. Combustion: Combustion phenomenon in S.I. Engines, Ignition delay, Velocity of flame propagation, pressure - crank angle diagram, detonation, factors affecting combustion and detonation, types of combustion chambers. 2.4. Petrol Injection - MPFI etc.	08
Module 03	3. C. I. Engines: 3.1 Requirement of Fuel Injection Systems, Types of fuel injection system viz. Common rail, individual pump, distributor and unit injector systems. High pressure fuel injection pump, Types of Nozzles. 3.2 Necessity of Governor in Diesel engines, Governor characteristics. 3.3 Combustion: Combustion phenomenon in C.I. Engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers.	08

<p>Module 04</p>	<p>Supercharging /Turbo charging: 4.1 Objectives of Supercharging / Turbo charging. 4.2.Effect of Supercharging / Turbo charging on power output and efficiency of the engine 4.3 Methods of Supercharging / Turbo charging. Types of Superchargers / Turbochargers SA Limit of Supercharging / Turbo charging. 4.4 Performance Characteristics of S.I. & C.I. Engines 4.4.1 Effect of load and speed on mechanical, indicated, brake thermal and volumetric efficiencies. Brake mean effective pressure and Brake specific fuel consumption, Heat balance test. 4.4.2 Method of determining indicated power of the engine.</p>	<p>10</p>
<p>Module 05</p>	<p>5. Exhaust Gas Analysis and Air Pollution: 5.1 Necessity of exhaust gas analysis. Constituents of exhaust gas, Orsat apparatus for carrying out exhaust gas analysis. 5.2. Different methods of determining Air/Fuel ratio. 5.3 Fuels of I.C. Engines: 5.3.1 Requirement of fuels. 5.3.2 Classification of hydrocarbon fuels. 5.3.3 Physical and Chemical properties of fuels. 5.3.4 Rating of Fuels - Octane No., Cetane No. & Performance No. Determination of Octane and Cetane Nos. 5.4 Non-Conventional fuels for I.C. Engines. CNG, LPG, Hydrogen, Bio- fuels, alcohol etc. 5.5. Air Pollution due to engine exhaust 5.5.1 Pollution control devices and EURO standards</p>	<p>08</p>
<p>Module 06</p>	<p>6. Engine Lubrication: 6.1 Types of lubricants used in I.C. Engines. 6.2 Properties of Lubricants. 6.3 SAE Ratings of Lubricants. 6.4 Types of Lubrication Systems 6.5 Engine Cooling: 6.5.1 Systems of Cooling - Air, Water-cooling. General arrangements. 6.6 Introduction to Stratified Charge and Wankel engines. 6.7. Recent developments in I. C. Engines.</p>	<p>08</p>

List of Experiments:

- 1) Study of carburetor.
- 2) Study of ignition system.
- 3) Study of fuel injection system.
- 4) Morse Test on petrol engine.
- 5) Speed Test on petrol or/and diesel engine.
- 6) Load Test on diesel engine (engines).
- 7) Heat Balance test on diesel or petrol engines.
- 8) Experimental determination of Air fuel ratio.
- 9) Exhaust Gas/Smoke analysis of S.I. / C.I. engines
- 10) Effect of Supercharging on Performance Characteristics of an engine.

Practical Examination:

Practical examination of 2 hours duration based on the laboratory experiments. Viva-voce can be conducted during practical examination.

Theory Examination:

1. Question paper will comprise of total seven question, each of 20 Marks
2. Question one will be compulsory and based on maximum part of syllabus.
3. Remaining questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only five question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Term Work:

Term work shall consist of minimum 08 experiments, assignments and written test. The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/assignments): (15) Marks.
- Test (at least one): (10) Marks.
- TOTAL: (25) Marks.**

Text Books:

1. Internal Combustion Engine - Mathur and Sharma
2. Internal Combustion Engine - E.F. Obert.
3. Internal Combustion Engine - Domkundwar
4. Internal Combustion Engine - V. Ganesan - *Tata McGraw Hill*

References:

1. Internal Combustion Engines - Richard Stone - *Palgrave Publications.*
2. Internal Combustion Engine - S.L. Beohar
3. Internal Combustion Engine - Gills and Smith.
4. Internal Combustion Engine - P.M. Heldt.
5. Power Plant Engineering - Morse
6. Internal Combustion Engines - V.L. Maleeve
7. Internal Combustion Engines - Taylor.
8. Internal Combustion Engines Fundamentals - John B. Heywood
9. Internal Combustion Engines S.S.Thipse,JAICO.
10. Internal Combustion Engines Willard w.pulkrabek, Pearson Education.

CLASS: T.E. (Mechanical/Automobile)		Semester:- VI	
SUBJECT: MACHINE DESIGN - I			
Periods per week. 1 Period of 60 min.	Lecture	04	
	Practical	02	
	Tutorial	--	
		Hours	Marks
Evaluation System	Theory Examination	04	100
	Practical	--	
	Oral Examination	--	25
	Term Work	--	25
	TOTAL		150

Sr. No.	Details	Hrs.
Module 01	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design Material properties and their uses in design Manufacturing considerations in design: tolerances, types of fits, selection of fits Design considerations of casting and forging Basic principles of Machine Design, Modes of failures, Factor of safety, Design stresses, Principle Stresses, Theories of failures Standards, I. S. codes, Preferred Series and numbers.	06
Module 02	Design against static Loads: Cotter joint, knuckle joint, Turn Buckle Bolted and welded joints under eccentric loading. Power Screw - Screw Presses along with the Frame	12
Module 03	Design against Fluctuating Loads Variables stresses, reversed, repeated, fluctuating stresses Fatigue Failure Static and fatigue stress concentration factors Endurance limit - estimation of endurance limit Design for finite and infinite life Soderberg and Goodman design criteria Fatigue design under combined stresses	06
Module 04	Design of shaft - power transmitting, power distribution shafts (excluding crank shaft) under static and fatigue criteria. Keys - Types of Keys and their selection based on shafting condition. Couplings- Classification of coupling. Selection of Standard Bush Pin coupling	10
Module 05	Design of springs- Helical compression, tension springs under static and variable loads, Laminated Springs.	06
Module 06	Design of Belts - Flat and V belt with Pulley construction Selection of Standard Roller chains.	08

Oral Examination:

Oral examination will be on maximum portion of syllabus.

TERM WORK:

Term work shall comprise of

- 1) Exercises on the above topics in the form of design calculations with sketches and or drawings.
- 2) At least four A-2 size drawing sheets shall be submitted.
- 3) Class Test based on above syllabus.
- 4) Class Assignments
- 5) Stress analysis of any machine element mentioned in the syllabus using any application software like ANSYS/MSC.NASTRAN/ABACUSS, etc.

The distribution of marks for term work shall be as follows:

Class Assignments, Drawing Sheets and software exercise	:	15 Marks
Class test	:	10 Marks
Total	:	25 Marks

NOTE:

Use of standard design data books like PSG Data Book , Design Data by Mahadevan is permitted at the examination and shall be supplied by the college.

Theory Examination:

- 1) Question paper will comprise of total seven question, each of 20 Marks
- 2) Question one will be compulsory and based on maximum part of syllabus.
- 3) Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4) Only five question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

TEXT BOOKS:

- 1) Design of machine elements -- V. B. Bhandari, *Tata McGraw Hill Pub.*
- 2) Design of machine elements -- Sharma, Purohit, *Prentice Hall India Pub.*
- 3) Machine Design - An Integrated Approach -- Robert L. Norton - *Pearson Education.*
- 4) Machine Design - Pandya & Shah - *Charotar Publishing.*
- 5) Mechanical Engineering Design - J. E. Shigley - *McGraw Hill*
- 6) Recommended Data Books - PSG, K. Mahadevan

REFERENCES:

Machine Design	- Reshetov - <i>Mir Publication</i>
Machine Design	- Black Adams - <i>McGraw Hill</i>
Fundamentals of Machine Elements	- Hawrock, Jacobson - <i>McGraw Hill</i>
Machine Design	- Patel, Pandya, Sikh, Vol. - I & II, C. Jamnadas & Co. <i>Educational & Law Publishers</i>
Design of Machine Elements	- V.M. Faires.
Design of Machine Elements	- Spotts.