Kavayitri Bahinabai Chaudhari
NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Fourth Year Engineering

(Mechanical Engineering)

Faculty of Science and Technology

कवयित्री बहिणाबाई चौधरी उत्तर महाराष्ट्र विद्यापीठ
अंतरी पेटवू ज्ञानज्योत
1990
'A' Grade
NAAC Re-Accredited
3rd Cycle

SYLLABUS STRUCTURE

Semester – VII &VIII

W.E.F. 2020 – 21

Subject Group Code and Subject Groups

Sr. No.	GROUP	Category	Breakup of Credits (Total 171)
1	**A**	Humanities and Social Sciences including Management Courses (HSMC)	**10**
2	**B**	Basic Science Courses (BSC)	**30**
3	**C**	Engineering Science Courses including workshop, drawing, basics of electrical/mechanical/computer etc. (ESC)	**33**
4	**D**	Professional Core Courses (PCC)	**53**
5	**E**	Professional Elective Courses relevant to chosen specialization/branch (PEC)	**18**
6	**F**	Open subjects – Electives from other technical and /or emerging subjects (OEC)	**12**
7	**G**	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad (PROJ)	**15**
8	**H**	Mandatory Courses (MC) [Environmental Sciences, Induction program, Indian Constitution, Essence of Indian Traditional Knowledge]	(non-credit)
		Total	**171**

Kavayatri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Bachelor of Engineering (Mechanical Engineering)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
3rd Cycle

Syllabus Structure & Contents of Fourth Year of Engineering

Semester-VI

w.e.f. 2020 – 2021

Syllabus Structure for Fourth Year Engineering (Semester – VII) (Mechanical Engineering) (w.e.f. 2020 – 21)

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Design of Machine Elements	**D**	**3**	**--**	**--**	**3**	40	60	--	--	100	**3**
Professional Elective Courses – III	**E**	**3**	**--**	**--**	**3**	40	60	--	--	100	**3**
Professional Elective Course – IV	**E**	**3**	**--**	**--**	**3**	40	60	--	--	100	**3**
Open Elective Course – III	**F**	**3**	**--**	**--**	**3**	40	60	-	-	100	**3**
Design of Machine Elements Lab	**D**	**--**	**--**	**2**	**2**	--	--	25	25 (OR)	50	**1**
Computer Aided Design Lab	**D**	**1**	**--**	**2**	**3**	--	--	25	25 (PR)	50	**2**
Project (Stage – I)	**G**	**--**	**--**	**12**	**12**	--	--	50	50 (OR)	100	**6**
Essence of Indian Traditional Knowledge	**H**	**--**	**--**	**--**	**--**	-	-	--	--	--	**0**
		13	**--**	**16**	**29**	**160**	**240**	**100**	**100**	**600**	**21**

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

Professional Elective Course – III	Professional Elective Course – IV	Open Elective Course – III
1) Automation in Manufacturing	1) Mechatronic Systems	1) Machinery Condition Monitoring
2) Operation Research	2) Advanced Machining Processes	2) Data Base Management
3) Electrical & Hybrid Vehicles	3) Power Plant Engineering	3) Microprocessor & Microcontrollers in automation
4) Mechanical Vibration	4) Product Design	4) Research Methodology

Syllabus Structure for Fourth Year Engineering (Semester – VIII) (Mechanical Engineering) (w.e.f. 2020 – 21)

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Refrigeration & Air Conditioning	**D**	3	--	--	3	40	60	--	--	100	**3**
Professional Elective Course – V	**E**	3	--	--	3	40	60	--	--	100	**3**
Professional Elective Course – VI	**E**	3	--	--	3	40	60	--	--	100	**3**
Open Elective Course – IV	**F**	3	--	--	3	40	60	-	-	100	**3**
Refrigeration & Air Conditioning Lab	**D**	--	--	2	2	--	--	25	25 (OR)	50	**1**
Finite Element Analysis & Simulation Lab	**D**	2	--	2	4	--	--	25	25 (PR)	50	**3**
Project	**G**	--	--	6	6	--	--	50	50 (OR)	100	**3**
		14	**--**	**10**	**24**	**160**	**240**	**100**	**100**	**600**	**19**

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

Professional Elective Course – V	Professional Elective Course – VI	Open Elective Course – IV
1) Robotics 2) 3D printing 3) Renewable Energy Sources & Technology 4) Design of Transmission System	1) Total Quality Management 2) Automobile Engineering 3) Computational Fluid Dynamics 4) Gas Dynamics & Jet Propulsion	1) Entrepreneurship, Innovations & Startups 2) Industrial & System Engineering 3) Internet of Things 4) Artificial Intelligence

DESIGN OF MACHINE ELEMENTS					
COURSEOUTLINE					
Course Title:	**Design of Machine Elements**	**Short Title:**	**DOME**	**Course Code:**	

Course Description:

This course aims to equip the mechanical engineering students with the fundamentals of design activities and give them necessary skills to prepare complete, concise, and accurate calculation steps for machine elements. While the first part of the machine elements covering general stress analysis, failure conditions, shaft, spring, permanent and nonpermanent joints design, rolling contact and journal bearings, gears, clutches, flywheels, etc.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	03	14	42	03

Pre-requisite Course(s):

The sound knowledge of Mathematics (Calculus), Engineering Mechanics, SOM and TOM subjects

Course Objectives:

1. To understand procedure of machine design and develop an ability to apply it for simple component design by using design data hand book.
2. To understand the different theories of failure and develop an ability to apply its knowledge for design of mechanical component and determine the resisting areas against failure
3. To determine forces on transmission shaft and design of transmission shaft
4. To determine the endurance strength and design of components subjected to fluctuating loads
5. To determine the forces in welds and bolt joints and formulate design solution for size of weld and size of bolt
6. To study standard procedure of bearing selection from manufacturing catalogue

Course Outcomes:

After successfully completion of this course students will be able to:

1. apply knowledge of the stress and strain of mechanical components; and understand, identify and quantify factor of safety, failure modes for simple mechanical components (Shaft and Coupling) subjected to direct and bending and combined loading.
2. develop logical and analytical ability to apply knowledge of various theories of failures for design of joints, bolts, springs etc.
3. the selection of gear types, sizing, analysis and material selection of spur and helical gear systems.
4. the selection of gear types, sizing, analysis and material selection of bevel and worm gear systems.
5. estimate endurance strength of ductile and brittle materials and develop analytical ability to apply fatigue theories for ductile and brittle material in static and dynamic loading.

COURSE CONTENT

Design of Machine Elements		**Semester:**	**VII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**

	Duration of ESE:	**03 hours**
	Internal Sessional Exams (ISE):	**40 marks**

Unit – I: Introduction and Design of Shaft and coupling	**No. of Lectures: 08 hours**	**Marks: 12**
Introduction of Machine Design, Basic procedure of Machine Design, Requisites of design engineer, Sources of design data, Design considerations - limits, fits and standardization, Selection of preferred sizes, Stress concentration - causes and remedies, Review of failure theories for static loading. Shafts: - Material, Design on the basis of strength considering shaft subjected to, twisting moment only, bending moment only, combine twisting and bending moment, axial load in addition to twisting and bending. Design on the basis of rigidity. A.S.M.E. code for shaft design. Couplings: - Design considerations, Classification, Design of Flange coupling and Flexible bushed pin coupling.		

Unit – II: Design of Joints, Spring	**No. of Lectures: 08 hours**	**Marks: 12**
Threaded Joints: - Stresses in threaded joint, Bolts of uniform strength, eccentrically loaded bolted joint, Torque requirement for bolt tightening. Welded Joints: - Types of welding and joints, strength of transverse and parallel fillet welded section, eccentrically loaded joint. Spring: - Types, Applications and materials of springs, Stress and deflection equations for helical springs, Style of ends, Wahl's Stress Factor, Design of helical compression and tension springs, leaf spring, nipping, Shot peening		

Unit – III: Design of Spur Gear and Helical Gear	**No. of Lectures: 09 hours**	**Marks: 12**
Spur Gears: Number of teeth and face width, Type of gear tooth failure, Desirable properties and selection of gear material, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength equation, Estimation of module based on beam and wear strengths, Estimation of dynamic tooth load by velocity factor and Buckingham's equation, Helical Gears: Transverse and normal module, Virtual number of teeth, Force analysis, Beam and Wear strengths, Effective load on gear tooth, Estimation of dynamic load by velocity factor and Buckingham's equation, Design of helical gears.		

Unit – IV: Design of Bevel Gears and Worm Gear	**No. of Lectures: 09 hours**	**Marks: 12**
Bevel Gears Straight tooth bevel gear terminology and geometric relationship, Formative number of teeth, Force analysis, Design criteria of bevel gears, Beam and wear strengths, Dynamic tooth load by velocity factor and Buckingham's equation, Effective load, Design of straight tooth bevel gears, Selection of material for bevel gears, Worm Gear Worm and worm gear terminology and geometrical relationship, Standards dimension, Force analysis of worm gear drives, Friction in worm gears and its efficiency, Worm and worm-wheel material, Beam strength and wear strength of worm gears, Thermal consideration in worm gear drive, Methods of Gears lubrication		

Unit – V: Design of Bearings and Design for Fluctuating Loads	**No. of Lectures: 08 hours**	**Marks: 12**

Rolling contact Bearings: Type of rolling contact bearing, Static and dynamic load carrying capacities, Striback's equation, Equivalent bearing load, Load-life relationship, Selection of bearing life, Selection of rolling contact bearings from manufacturer's catalogue. Design for cyclic loads and speed, bearing with probability of survival other than 90%. Design for Fluctuating Loads: Fluctuating stresses, Fatigue failure, Endurance limit, Notch sensitivity, Reversed stresses, Solderberg and Goodman diagrams, Fatigue design of components under combined stresses such as shafts, bolts and springs.
Text Books:
1. Bhandari V.B., "Design of Machine elements", Tata McGraw Hill Pub. Co. ltd. 2. Farzdak Haideri, "Machine Design", Nirali Prakashan, Pune 3. R. B. Patil, "Mechanical System Design" Techmax publications; 4th edition (2018)
Reference Books:
1. Shigley J.E., Mischke C.R., "Mechanical Engineering Design" McGraw Hill Pub. Co. Ltd. 2. Spott's M. F., Shoup T. E. "Design of Machine Elements", Prentice Hall International. 3. "Design Data", P.S.G. College of Technology, Coimbatore. 4. Juvinal R. C. "Fundamental of Machine Component Design", John Wiley and sons. 5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

AUTOMATION IN MANUFACTURING					
COURSE OUTLINE					
Course Title:	**Automation in Manufacturing**	**Short Title:**	**AM**	**Course Code:**	

Course Description:

Automation in manufacturing is key to success in cost cutting of manufacturing and material handling.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

English

Course Objectives:

The objectives of this course is to introduce the main principles of automation, to generate knowledge and skills of students to use automation systems and devices for the implementation of it in manufacturing industry.

Course Outcomes:

After successfully completion of this course students will be able to:
1. Understand production systems and elements of automated system.
2. Understand types of material handling and identification technologies.
3. Identify the components of manufacturing and assembly lines.
4.Understand role of cellular manufacturing;
5. Learn various low-cost automation systems

COURSE CONTENT

Automation in Manufacturing		**Semester:**	**VII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	**No. of Lectures: 09 hours**	**Marks: 12**

Over View of Manufacturing and Automation: Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

Unit – II:	**No. of Lectures: 09 hours**	**Marks: 12**

Material Handling and Identification Technologies: Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

Unit – III:	**No. of Lectures: 08 hours**	**Marks: 12**

Manufacturing Systems and Automated Production Lines: Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual

Assembly lines, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Automated Assembly Systems: Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, hybrid systems, comparative evaluation.		
Text Books:		
1. Modern Machining Process, Pandey and Shan, TMH Manufacturing Automation 2. Automation, production systems and computer integrated manufacturing/ Mikell. P Groover/PHI/3rd edition/2012. 3. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers/2003.		
Reference Books:		
1. G. Pippengerm, Industrial Hydraulics, MGH, New York, 1979. 2. F. Kay, Pneumatics for Industry, The Machining Publishing Co., London, 1969. 3. A. Ray, Robots and Manufacturing Assembly, Marcel Dekker, New York, 1982. 4. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96 5. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009 6. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers 7. Metal Cutting Mechanics, Machine Tool Vibrations, CNC Design, Yusuf, Cambridge University Press		

Operations Research					
COURSE OUTLINE					
Course Title:	**Operations Research**	**Short Title:**	O.R.	**Course Code:**	FILL HERE

Course description:

Operations research (OR) have many applications in science, engineering, economics, and industry and thus the ability to solve OR problems are crucial for both researchers and practitioners. Being able to solve the real-life problems and obtaining the right solution requires understanding and modelling the problem correctly and applying appropriate optimization tools and skills to solve the mathematical model. The goal of this course is to teach you to formulate, analyze, and solve mathematical models that represent real-world problems.

	Hours/week	No. of weeks	Total hours	Semester credits
Lecture	3	14	42	3

Prerequisite course(s):

Familiarity with linear algebra is required.

Course objectives:

Students to use quantities methods and techniques for effective decisions–making; model formulation and applications that are used in solving business decision problems.

Course outcomes:

After successful completion of this course the student will be able to:

1. Use methods of the graph in solving linear program and to find the optimal solution
2. Use the method simplex and to find the optimal solution.
3. Build and solve Transportation Models and Assignment Models.
4. Describe the characteristics of different types of decision-making environments and the appropriate decision-making approaches and tools to be used in each type.
5. Build and solve Replacement Models and Sequencing Models.

COURSE CONTENT

Operations Research		**Semester:**	**VII**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**

Operation Research – An Introductions

The history of OR, Definition, Features, of OR, models and modelling in OR, OR approach to problem solving, methods for solving OR models, phases of OR, Advantages of OR study, Shortcomings of OR approach, OR Models in Practice, Applications of OR.

Unit–II:	**No. of Lectures: 10 Hours**	**Marks: 12**

Linear Programming- Introduction, general Stricture of LP model, Assumption of an LP model, Advantages and Limitations of Linear programming, Applications areas of LP, steps

of LP Model formulation, Graphical solution methods of LP problem, maximization, minimization, feasible, infeasible and unbounded solution.
The simplex method Introduction, standard form of an LP problem, simplex algorithm (maximization, minimization case) Degeneracy in simplex problem, unbounded Infeasible solution.
Duality in Linear programming, formulation of dual LPP, Advantages of duality, rules for constructing the Dual from primal, sensitivity Analysis in LP

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Transportation problem introduction, mathematical model of transportation problem, Algorithm, methods for finding initial solution northwest corner method, least cost method, Vogel's Approximation method, test for optimality steps of MODI method, maximization problem, unbalanced, degeneracy, prohibited transportation Routes problem.
Assignment problem- introduction, mathematical models of assignment problem, solution method of assignment problem, Hungarian method, maximization case, unbalanced Restrictions on assignment, travelling salesman, problem.

Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**

Decision Theory- Introduction, steps in decision making process types of decision-making Environments, Decision tree.
Theory of games- introduction, Two-person Zero sum game, pure strategies, maximin, minimax principles, game with saddle point, mixed strategy games, The principles of dominance, games without saddle point, algebraic method, arithmetic method, sub game method, Graphical method.

Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**

Replacement and maintenance method- Introduction, types of failure- gradual failure, sudden failure Replacement of items whose efficiency deteriorates with time, Replacement of items that completely fail, individual replacement policy, Group replacement policy, staffing problem, failure trees.
Sequencing problem- Introduction notations, Terminology, and assumptions of sequencing problem, Processing n jobs through two machines, Processing n jobs through three machines, Processing n jobs through four machines, Processing n jobs through five machines Graphical method.

Text Books:

1. Gupta, P.K. and Hira, D.S. (2008) Operations Research. S. Chand and Company Limited, New Delhi.
2. S. D. Sharma, "Operation Research", Khanna Publication
3. Manohar Mahajan, "Operation Research", Dhanpat Rai and Co.

Reference Books:

1. Taha, "Introduction to Operations Research." PHI Publications.
2. J. K. Sharma, "Operation Research, Problem and Solution", Macmillan
3. N. D. Vohra, "Quantitative Techniques in Management", TATA McGraw Hill
4. Ravindran, "Operation Research Principles and Practice", Wiley India Pvt. Ltd. New Delhi
5. Wayne L. Winston, "Practical Management Science: Spreadsheet modelling and applications", Duxbury Press,

ELECTRICAL AND HYBRID VEHICLES

COURSEOUTLINE

Course Title:	Electrical and Hybrid Vehicles	Short Title:	EHV	Course Code:	

Course Description:

This course will provide you with a broad technical knowledge and practical expertise of hybrid and electric vehicle (HEV) technologies, analysis, design, component selection and sizing at both system and vehicle level.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Basics of electrical and electronics engineering, Control Systems Engineering, Electrical Machines

Course Objectives:

1. To study the concepts and drive train configurations of electric drive vehicles
2. To provide different electric propulsion systems and energy storage devices
3. To explain the technology, design methodologies and control strategy of hybrid electric vehicles
4. To emphasize battery charger topologies for plug in hybrid electric vehicles

Course Outcomes:

After successfully completion of this course students will be able to:

1. Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources
2. Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
3. Choose proper energy storage systems for vehicle applications.
4. Identify various communication protocols and technologies used in vehicle networks.
5. Understand energy management strategies.

COURSE CONTENT

Electrical and Hybrid Vehicles		Semester:	VII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I:	No. of Lectures: 09 hours	Marks: 12

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Unit – II:	No. of Lectures: 09 hours	Marks: 12

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis		
Unit – III:	**No. of Lectures: 08 hours**	**Marks: 12**
Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives. Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies		
Text Books:		
1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011. 2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.		
Reference Books:		
1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010. 2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000 3. http://nptel.ac.in/courses/108103009/		

MECHANICAL VIBRATION

COURSEOUTLINE

Course Title:	Mechanical Vibration	Short Title:	MV	Course Code:	

Course Description:

This course introduces undergraduate students to Mechanical Vibration. The background required includes a sound knowledge of Mathematics (Calculus), Engineering Mechanics, Strength of materials and Theory of mechanics of second year and Third year Level. The course aims at imparting knowledge of Mechanical vibration.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s): Mathematics (Calculus) at First year level and strength of Materials, Theory of Machines at Second year Level.

Course Objectives:

1. To understand the fundamentals of Vibration Theory.
2. To be able to mathematically model real-world mechanical vibration problems.
3. To analyse oscillatory motion of dynamic systems and the forces associated with the motion.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Determine the natural frequency of Fundamental of Vibrations & Undamped Free Vibrations.
2. Analyze the Damped Free &Forced Vibrations of Single Degree of Freedom Systems.
3. Compute the natural frequencies Two Degree of Freedom Systems.
4. Select the numerical methods to determine Multi Degree of Freedom Systems Exact Analysis.
5. Describe the vibration measurement Continuous Systems & Non-Linear Vibrations

COURSE CONTENT

Mechanical Vibration		Semester:	VII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I:	No. of Lectures: 09 hours	Marks: 12

FUNDAMENTAL OF VIBRATIONS- Introduction, Definitions, Vector method of representing harmonic motions, Addition of two simple harmonic motions of the same frequency, Beat phenomenon, Complex method of representing harmonic vibrations, Work done by a harmonic force on a harmonic motion. UNDAMPED FREE VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEMS - Introduction, Derivation of differential equation, Solution of differential equation, Torsional vibrations, Equivalent stiffness of spring combinations, Energy method.

Unit – II:	**No. of Lectures: 09 hours**	**Marks: 12**
DAMPED FREE VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEMS- Introduction, Different types of damping's, Free vibrations with viscous damping, Logarithmic decrement. Viscous dampers, Dry friction or coulomb damping, Solid or structural damping, Slip or interfacial damping. FORCED VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEMS- Introduction, forced vibrations with constant harmonic excitation, Forced vibrations with rotating and reciprocating unbalance, Forced vibrations due to excitation of support. Vibration isolation and transmissibility.		
Unit – III:	**No. of Lectures: 08 hours**	**Marks: 12**
TWO DEGREE OF FREEDOM SYSTEMS- Introduction, Principal modes of vibration, Other cases of simple two degree of freedom systems, Combined rectilinear and angular modes. System with damping, Undamped forced vibrations with harmonic excitation, Vibration absorbers.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
MULTI DEGREE OF FREEDOM SYSTEMS EXACT ANALYSIS- Introduction, Free vibrations equations of motion, Influence coefficients, Generalized coordinates and coordinate coupling. Natural frequencies and mode shapes, Forced vibrations by N's second law of motion, Torsion vibrations of multi-rotor systems. MULTI DEGREE OF FREEDOM SYSTEMS NUMERICAL METHODS- Introduction, Rayleigh's method, Dunkerley's method, Stodola's method.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
CONTINUOUS SYSTEMS- Vibrations of strings, Longitudinal vibrations of bars, Torsional vibrations of circular shafts, Lateral vibrations of beams. NON-LINEAR VIBRATIONS- Introduction, Examples of non-linear systems, Phase plane, Undamped free vibration with nonlinear spring forces, Pertubation method, Forced vibration with non-linear spring forces, Self-excited vibrations.		
Text Books:		
1. V. P. Singh, "Mechanical Vibrations", Dhanpat Rai & Co. (P) Ltd., Delhi 2. G. K. Grover "Mechanical Vibrations", New Chand & Bros Roorkee (U.P.)		
Reference Books:		
1. Dilip Kumar Adhwarjee "Theory and Applications of Mechanical Vibrations", Laxmi Publications (p) Ltd., New Delhi 2. Leonard Meirovitch "Element of Vibration Analysis" Tata McGraw-Hill Publishing Company Limited, New Delhi 3. Singiresu S. Rao "Mechanical Vibrations", Pearson Education Ptd. Ltd., Delhi 4. S. Graham Kelly "Schaum's Outlines Mechanical Vibrations", Tata McGraw-Hill Publishing Company Limited, New Delhi 5. B. H. Tongue," Principles of Vibration", 2/ed. Oxford University Press, New Delhi		

MECHATRONIC SYSTEMS

COURSEOUTLINE

Course Title:	Mechatronic Systems	Short Title:	MS	Course Code:	

Course Description:

Mechatronics is a multi-disciplinary study dealing with the integration of mechanical devices, actuators, sensors, electronics, intelligent controllers and computers. Many new generations of consumer or commercial products can be classified as mechatronic products as they involve mechanical as well as electronic components.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

The sound knowledge of Mathematics (Calculus), Engineering Mechanics, SOM and TOM subjects

Course Objectives:

(i) To understand the structure of microprocessors and their applications in mechanical devices
(ii) To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
(iii) To understand the use of micro-sensors and their applications in various fields

Course Outcomes:

Upon completion of this course, students will be able to:
1. Understand how different physical variables are measured and illustrate their working principles
2. Identify and select proper sensors and transducers for specific applications
3. Understand issues of implementation of MEMS & Touch sensors
4. Understand different types of actuators and their implementation
5. Design the pneumatic and hydraulic system.

COURSE CONTENT

Mechatronic Systems		Semester:	VII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I: Fundamentals of Mechatronics	No. of Lectures: 08 hours	Marks: 12

Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology

Unit – II: Sensors and Transducers	No. of Lectures: 08 hours	Marks: 12

Introduction, Significance of Sensor Measurements, Classification of Sensors, Analog vs Digital Sensors

Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.

Dynamic Characteristics: Sensor bandwidth and frequency response

Signal conditioning: Amplifier, Conversion, Filtering, Impedance Buffering Types of errors, Effect of component errors, Probable errors. Selection criteria of sensors for mechatronic systems. Sensors**:** Displacement and Position Sensors, Velocity, Force, Motion and Pressure Sensors, Temperature and Light Sensors,

Unit – III: MEMS and Touch sensors	**No. of Lectures: 08 hours**	**Marks: 12**

MEMS Sensors: Micro Electro Mechanical System (MEMS) Sensors, Working Principle, MEMS accelerometers, MEMS gyroscopes, MEMS pressure sensors, MEMS magnetic field sensors, Advantages, Applications, Air Bag Crash Sensors, Antilock Brake System, Active Suspension System,

Touch Sensors: Working Principle, capacitor Type Touch Sensors, Resistive Touch sensors, Applications,

Unit – IV: Drives and Controls	**No. of Lectures: 09 hours**	**Marks: 12**

Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems. open and closed loop control; Embedded Systems, Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems.

Unit – V: Hydraulic & Pneumatic system	**No. of Lectures: 09 hours**	**Marks: 12**

Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits.

Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Smart materials: Shape Memory Alloy, Piezoelectric and Magneto strictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.;

Text Books:

1. Boucher, T. O., Computer automation in manufacturing - an Introduction, Chapman and Hall, 1996.
2. HMT ltd. Mechatronics, Tata Mc graw Hill, New Delhi, 1988
3. Deb,S. R., Robotics technology and flexible automation, Tata McGraw-Hill, New Delhi, 1994.
4. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 1999.
5. A Textbook of Mechatronics, R. K. Raput, S. Chand Publishing
6. Mechatronics: Principles, Concepts and applications, Mahalik N.P, Tata McGraw Hill

Reference Books:

1. Introduction to Mechatronics, Kuttan, Oxford University
2. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall

3. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)

ADVANCED MACHINING PROCESSES

COURSE OUTLINE

Course Title:	Advanced Machining Processes	Short Title:	AMPs	Course Code:	

Course Description:

The traditional machining methods even with added CNC features are unable to meet stringent demands of various industries such as electronics, automobiles, aerospace etc. As a result, a new class of machining processes has evolved over a period of time to meet such demands, named non-traditional, unconventional, modern or advanced machining processes. These advanced machining processes (AMPs) become still more important when one consider precision and ultra- precision machining. These advanced machining processes are based on the direct application of energy for material removal by mechanical erosion, thermal erosion or electro- chemical/ chemical dissolution.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Workshop Practice, Manufacturing Technology

Course Objectives:

In today technology development scenario, there is a requirement to develop a machine tool and the processes that can easily machine difficult- to- cut material or a workpiece to produce desired shape and accurate profile. To overcome these challenges number of new material removal processes has been developed. These new material removal methods are also called as non-conventional where conventional tools are not suitable for machining. This course will provide the students up-to-date with the latest technological developments and research trends in the area of unconventional/non-traditional/modern machining processes.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Understand various advanced machining processes with their advantages, disadvantages and their applications.
2. Able to understand different types of composite material characteristics, types of micro & nan machining processes
3. Select a proper NTM method for given component
4. Understand concepts of machining for selection of appropriate machining parameters, and cutting tools for ECM
5. To learn the concepts and principles of advanced chemical machining processes

COURSE CONTENT

Advanced Machining Processes		Semester:	VII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I:	No. of Lectures: 09 hours	Marks: 12

Bulk Material Removal Processes: Introduction: - Abrasive jet machining setup-Gas propulsion system-abrasive feeder-machining chamber-AJM nozzle-Abrasives, Process capabilities, applications, Introduction and working: - Ultrasonic Machining system, Process capabilities, applications, Introduction and working:- Water Jet Machining (WJM) and Abrasive water jet machining (AWJM)		
Unit – II:	**No. of Lectures: 09 hours**	**Marks: 12**
Micro/Nano finishing processes: Introduction, Abrasive flow machining (AFM) process variables, applications Magnetic abrasive finishing (MAF), Magneto-reheological finishing (MRF), Magnetic float polishing (MFP), Elastic emission machining (EMM), Ion beam machining (IBM).		
Unit – III:	**No. of Lectures: 08 hours**	**Marks: 12**
Thermal Advanced Machining Processes: - Introduction, Plasma arc machining (PAM), Laser beam machining (LBM), Electron beam machining (EBM), Electro-discharge machining (EDM).		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Electro-Chemical Machining: - Introduction, Electro Chemical Machining (ECM) principle, working, advantages, disadvantages, applications, Chemical Machining (ChM), Introduction, principle, working, advantages, disadvantages, applications		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Chemical Advanced Machining Processes: - Bio chemical machining (BM), Introduction, principle, working, advantages, disadvantages and applications, Electro chemical grinding (ECG), Introduction, ECG machine tool, process characteristics, applications.		
Text Books:		
1.Advanced Machining Processes by V. K. Jain, Allied Publishers, New Delhi 2009 2. Manufacturing Technology Volume 2 by P. N. Rao Tata McGraw Hill Education Private Limited, New Delhi. 2009 3.Gary F. Benedict, Non-Traditional Manufacturing Processes, Taylor & Francis 1987 4.J. A. Mcgeough, Advanced Methods of Machining, Springer 1988		
Reference Books:		
1. P. K. Mishra, Non-Conventional Machining, Narosa India publication, 1997 2. Hassan EI-Hofy, Advanced Machining Processes: Non-traditional and hybrid Machining Processes, McGraw-Hill 2005 3. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill 1980 4. James A. Brown, Modern Manufacturing Processes, Industrial Press, 1991 5. V. K. Jain, Introduction to Micromachining, Alpha Science International Limited, 2010		

Power Plant Engineering

COURSE OUTLINE

Course Title:	**Power Plant Engineering**	**Short Title:**	**PPE**	**Course Code:**	

Course Description:

To understand the various components, operations and applications of different types of power plants.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester Credits**
	3	**14**	**42**	**3**

Pre-requisite Course(s):

Fundamental knowledge of engineering thermodynamics, applied thermodynamics & turbo machinery.

Course Objectives:

To introduce students to different aspects of power plant engineering. To familiarize the students to the working of power plants based on different fuels. Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Explain the layout, construction and working of the components inside a thermal power Plant.
2. Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
3. Explain the layout, construction and working of the components inside nuclear power plants.
4. Explain the layout, construction and working of the components inside Renewable energy power plants.
5. Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

COURSE CONTENT

Power Plant Engineering		**Semester:**	**VII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I: COAL BASED THERMAL POWER PLANTS	**No. of Lectures: 08 hours**	**Marks: 12**

Rankine cycle – improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

Unit – II: DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS	**No. of Lectures: 08 hours**	**Marks: 12**
Otto, Diesel, Dual & Brayton Cycle – Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.		
Unit – III: NUCLEAR POWER PLANTS	**No. of Lectures: 08 hours**	**Marks: 12**
Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.		
Unit – IV: POWER FROM RENEWABLE ENERGY	**No. of Lectures: 09 hours**	**Marks: 12**
Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.		
Unit – V: ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS	**No. of Lectures: 09 hours**	**Marks: 12**
Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.		
Text Books:		
1. Nag. P.K., "Power Plant Engineering", Third Edition, TMH, New Delhi.		
Reference Books:		
1. El-Wakil. M.M., "Power Plant Technology", TMH, New Delhi 2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University. 3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill.		

PRODUCT DESIGN					
COURSE OUTLINE					
Course Title:	**Product Design**	**Short Title:**	**PD**	**Course Code:**	

Course Description:

This course is designed with focus on theory, technologies and practical applications in the product design, development and management over whole product lifecycle.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Metrology and Quality Control

Course Objectives:

This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front-end processes. At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Manage the development of an idea from concept through to production.
2. Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.
3. Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
4. Demonstrate, apply, explain, and recognize basic engineering, mechanical, and technical principles for decision making
5. Use sustainable materials and manufacturing processes & Carry out cost and benefit analysis through various cost models.

COURSE CONTENT

Product Design		**Semester:**	**VII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	**No. of Lectures: 09 hours**	**Marks: 12**

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research

Unit – II:	**No. of Lectures: 08 hours**	**Marks: 12**
Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance - establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies		
Unit – III:	**No. of Lectures: 09 hours**	**Marks: 12**
Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition –functional representation –morphological methods-TRIZ- axiomatic design.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Decision making –decision theory –utility theory –decision trees –concept evaluation methods –Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity-based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.		
Text Books:		
1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9		
Reference Books:		
1. Clive L. Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7 2. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9 3. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education, ISBN 9788177588217 4. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141		

MACHINERY CONDITION MONITORING

COURSE OUTLINE

Course Title:	Machinery Condition Monitoring	Short Title:	MCM	Course Code:	

Course Description:

The subject of machinery condition monitoring has been recently receiving considerable attention in India owing to concerns related to equipment reliability and safety. This increasing interest is primarily due to the significant impact of economic changes and strong competition in the global market.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Engineering mechanics, Strength of materials

Course Objectives:

The objectives of this course will provide students/engineers/managers with the state-of-the-art techniques in machinery condition monitoring along with the recent developments in the field of signal processing, thermography, ultrasonic apart from the traditional noise and vibration monitoring. There will be demonstration of real time machinery health monitoring by various condition monitoring aspects.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Understand the maintenance scheme, their scope and limitations – apply the maintenance strategies to various problems in the industrial sectors.
2. Analyse for machinery condition monitoring and explain how these compliments monitoring the condition.
3. Develop an appreciation for the need of modern technological approach for plant maintenance to reduce the maintenance expenditure.
4. Emphasizes on case studies that require gathering information using the modern testing equipment and processing it to identify the malfunction in that system.
5. Identify vibration measurement, lubrication oil analysis

COURSE CONTENT

Machinery Condition Monitoring		Semester:	VII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I:	No. of Lectures: 08 hours	Marks: 12

Introduction, Maintenance – objectives – types – concepts and economic benefits, Preventive maintenance – time based & condition based, Condition Monitoring & Performance monitoring, Vibration Monitoring – causes and effects of vibration, Review of Fundamentals of Vibrations.

Unit – II:	No. of Lectures: 08 hours	Marks: 12

Vibration Measuring Equipment -Sensors, Signal conditioners, recording elements, Sensors – Factors affecting the choice of sensors, Contact type sensors – Non contact type sensors, Signal conditioning – Display/Recording elements, Vibration meters and analyser, Overall Level Measurement, Vibration limits & Standards.		
Unit – III:	**No. of Lectures: 08 hours**	**Marks: 12**
Signal Analysis - Frequency Analysis, Measurement of overall vibrations levels, Vibration limits and standards, Case studies, Special Vibration Measuring Techniques, Shock Pulse Method, Kurtosis, Cepstrum Analysis, Critical speed analysis, Orbit, vibration control, Wear behavior monitoring and Contaminants Monitoring Technique, Filters, chip detectors, Ferrography, Oil Analysis – oil degradation analysis, Abrasive Particle in oil, counters, Particle classification and counter.		
Unit – IV:	**No. of Lectures: 09 hours**	**Marks: 12**
Performance trend monitoring – Primary and secondary parameters, Performance trend analysis, Performance trend monitoring systems, Case studies, Temperature Monitoring – Various techniques – thermometer, thermocouple, Thermography, infrared pyrometers.		
Unit – V:	**No. of Lectures: 09 hours**	**Marks: 12**
Corrosion Monitoring – different techniques, Selection of condition motoring techniques, Non-destructive techniques – important features, Types of defects detected by NDT – Visual, Dye Penetration, Acoustic Emission and its applications, Xray, Radiographic, Magnetic Flux test.		
Text Books:		
1. Amiya R. Mohanty, MCM, CRC Press.		
Reference Books:		
1. Isermann R., Fault Diagnosis Applications, Springer-Verlag, Berlin, 2011. 2. Rao, J S., Vibration Condition Monitoring, Narosa Publishing House, 2nd Edition, 2000. 3. Allan Davies, Handbook of Condition Monitoring, Chapman and Hall, 2000		

Database Management Systems					
COURSEOUTLINE					
Course Title:	**Database Management Systems**	**Short Title:**	**DMS**	**Course Code:**	

Course Description:

C language

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Course Objectives:

1. Students will understand different issues involved in the design and implementation of a database system.
2. Students will learn the physical and logical database designs, database modeling, relational, hierarchical, and network models
3. Students will learn the use of data manipulation language to query, update, and manage a database
4. Students will understand essential DBMS concepts such as: database integrity, concurrency and Indexing.
5. Students will think about applications of course material (to improve thinking, problem solving, and decisions)

Course Outcomes:

After successfully completion of this course students will be able to:

1. Identify entities in database and relate those entities
2. Construct the database queries in formal relational query languages
3. Construct the database queries in user oriented relational query language (SQL)
4. Normalize the database
5. Understand the concept of transaction processing system

COURSE CONTENT

Database Management Systems		**Semester:**	**VII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I: Introduction to DBMS	**No. of Lectures: 09 hours**	**Marks: 12**

Database-System Applications, Purpose of Database Systems, View of Data: Data Abstraction, Instances and Schemas, data independence, Data Models: Relational Model, Entity-Relationship Model, Object-Based data model, Semi structured Data Model, Database Languages, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators

Database Design and E-R Model: Overview of the Design Process, The Entity Relationship Model: Entity Sets, Relationship Sets, Attributes, Constraints , Entity-Relationship Diagram: Basic Structure, Mapping Cardinality, Roles, Weak Entity sets, Extended E-R Features:

Specialization, Generalization, Attribute Inheritance, Constraints on Generalizations, Aggregation		
Unit – II: Formal Relational Query Languages	**No. of Lectures: 09 hours**	**Marks: 12**
The Relational Algebra: Fundamental Operations: The select Operation, The Project Operation, The Union Operation, The Set-Difference Operation, The Cartesian-Product Operation, The Rename Operation, Formal definition of Relational Algebra, Additional Algebra Operations: The Set-Intersection Operation, The Natural-Join Operation, The Assignment Operation, Outer Join Operations, Extended Relational-Algebra Operations: Generalized Projection, Aggregation		
Unit – III: Structured Query Language	**No. of Lectures: 08 hours**	**Marks: 12**
Queries Introduction to relational Model: structure of relational Databases, Database Schema, Keys, Schema Diagrams, Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions Nested Subqueries, Modification of the Database **Intermediate SQL:** Joined Expressions: Join Conditions, Outer Joins, Views, Integrity Constraints Functions and Procedures, Triggers		
Unit – IV: Storage strategies and Relational Database Design	**No. of Lectures: 08 hours**	**Marks: 12**
Storage strategies - Indexing: Basic concepts, Ordered Indices, B+ tree Index Files **Relational Database Design:** Features of Good Relational Designs, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies: Keys and Functional Dependencies, Boyce-Codd Normal Form, BCNF and Dependency Preservation, Third Normal Form, Decomposition Using Multivalued Dependencies: Multivalued Dependencies, Fourth Normal Form		
Unit – V: Transaction Management and Architectures	**No. of Lectures: 08 hours**	**Marks: 12**
Transaction Management: Transaction Concept, A simple Transaction Model, Transaction Atomicity and Durability **Concurrency Control:** Lock-Based Protocols: Locks, Granting of Locks, The Two-Phase Locking protocol, Timestamp–Based Protocols: Timestamps, The Timestamps-Ordering Protocol **Recovery System:** Failure Classification, Storage, Recovery and Atomicity: Log records, Database Modification, Concurrency Control and Recovery, Transaction Commit, Using the Log to Redo and Undo Transactions **Database-System Architectures**: Centralized and Client–Server Architectures, Server System Architectures, Parallel Systems, Parallel Database Architectures**,** Distributed Systems		
Text Books:		
1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", 6th Edition, McGraw-Hill.		
Reference Books:		

1. R. Ramkrishnan , J. Gehrke, "Database Management Systems", 3rd Edition, McGraw-Hill.
2. C. J. Date, “Introduction to Database Management Systems”, 8th Edition, Pearson.
3. R. Elmasri and S. Navathe “Fundamentals of Database Systems”, 5th Edition,Pearson
4. V.K.Jain, “Database Management System”, Dreamtech Press (Wiley India).
5. AtulKahate, “Introduction to Database Management System”, 3rd Edition, Pearson.
6. G. K. Gupta, “Database Management Systems”, McGraw–Hill.
7. S. K. Singh, “Database Systems Concepts, Design and Applications”, Pearson.
8. Bipin Desai, “Introduction to database management systems”, Galgotia.

MICROPROCESSOR & MICROCONTROLLERS IN AUTOMATION					
COURSE OUTLINE					
Course Title:	**Microprocessor & Microcontrollers in automation**	**Short Title:**	**MPMCA**	**Course Code:**	

Course Description:

The objective of this course is to study the architecture and assembly language programming of microprocessor and microcontroller. To know about interfacing techniques of various I/O devices with microcontroller.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Basics in electrical and electronics engineering, C programming

Course Objectives:

The objective of this course is to study the architecture and assembly language programming of microprocessor and microcontroller. To know about interfacing techniques of various I/O devices with microcontroller.

Course Outcomes:

The student will be able to:
1. Understand the architecture of 8085 and 8086 Microprocessors
2. Develop the assembly language programs using 8086 instruction set
3. Understand the architecture of 8051 Microcontroller
4. Develop the assembly language programs using 8051 instruction set
5. Design the interfacing of I/O devices with 8051 Microcontroller

COURSE CONTENT

Machinery Condition Monitoring		**Semester:**	**VII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	No. of Lectures: 08 hours	Marks: 12

Architecture of Microprocessors: General definitions of mini computers, microprocessors, micro controllers and digital signal processors, Overview of 8085 microprocessor, Overview of 8086 microprocessor, Signals and pins of 8086 microprocessor.

Unit – II:	No. of Lectures: 08 hours	Marks: 12

Assembly language of 8086: Description of Instructions, Assembly directives, Algorithms with assembly software programs

Unit – III:	No. of Lectures: 08 hours	Marks: 12

Architecture of microcontroller: Overview of the architecture of 8051 Micro controller, Interfacing of external Memory, I/O devices and serial communication with typical microcontrollers.

Unit – IV:	**No. of Lectures: 09 hours**	**Marks: 12**
Assembly language of 8051: Description of Instructions, Assembly directives, Algorithms with assembly software programs.		
Unit – V:	**No. of Lectures: 09 hours**	**Marks: 12**
Interfacing with keyboards, LEDs, 7 segment LEDs, LCDs, ADCs, DACs.		
Text Books:		
1. Kenneth Ayala, "The 8051 Micro controller" Cengage Learning 2. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085" 5/e, Penram International Publishing Pvt. Ltd. 3. Douglas Hall, "Microprocessor and Interfacing", TMH.		
Reference Books:		
1. Ajay Deshmukh, "Micro controller: Theory and application", TMH. 2. Predko, "Programming and customizing 8051 Micro controller", TMH. 3. "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson		

RESEARCH METHODOLOGY

COURSE OUTLINE

Course Title:	Research Methodology	Short Title:	RM	Course Code:	

Course Description:

Research Methodology is a hands-on course designed to impart education in the foundational methods and techniques of academic research in social sciences and business management context.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Basic Mathematics, English

Course Objectives:

The course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach.

Course Outcomes:

After successfully completion of this course students will be able to:
1. develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. apply basic knowledge on qualitative research techniques
3. apply knowledge on measurement & scaling techniques as well as the quantitative data analysis
4. perform data analysis-and hypothesis testing procedures
5. write and interpret the report and thesis in technical way.

COURSE CONTENT

Research Methodology		Semester:	VII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I:	No. of Lectures: 09 hours	Marks: 12

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

Unit – II:	**No. of Lectures: 08 hours**	**Marks: 12**
Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing.		
Unit – III:	**No. of Lectures: 09 hours**	**Marks: 12**
Computer and its role in research, Use of statistical software SPSS, GRETL etc. in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.		

Text Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., “An introduction to Research Methodology”, RBSA Publishers.
2. Kothari, C.R., “Research Methodology: Methods and Techniques”, New Age International.
3. Sinha, S.C. and Dhiman, A.K., “Research Methodology”, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., “Research Methods: the concise knowledge base”, Atomic Dog Publishing.
5. Wadehra, B.L., “Law relating to patents, trademarks, copyright designs and geographical indications” Universal Law Publishing.

Reference Books:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., “Research Methods: A Process of Inquiry”, Allyn and Bacon.
2. Carlos, C.M., “Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options”, Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., "Proposal Writing", Sage Publications.
4. Day, R.A., “How to Write and Publish a Scientific Paper”, Cambridge University Press.
5. Fink, A., “Conducting Research Literature Reviews: From the Internet to Paper”, Sage Publications
6. Leedy, P.D. and Ormrod, J.E., “Practical Research: Planning and Design”, Prentice Hall.
7. Satarkar, S.V., “Intellectual property rights and Copy right”, Ess Ess Publications.

DESIGN OF MACHINE ELEMENT LAB

COURSEOUTLINE

Course Title:	**Design of Machine Element**	**Short Title:**	**DOME**	**Course Code:**	

Course Description:

This course aims to equip the mechanical engineering students with the fundamentals of design activities and give them necessary skills to prepare complete, concise, and accurate calculation steps for machine elements. While the first part of the machine elements covering general stress analysis, failure conditions, shaft, spring, permanent and nonpermanent joints design, rolling contact and journal bearings, gears, clutches, flywheels, etc.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester Credits**
	02	**14**	**28**	**01**

Pre-requisite Course(s):

The sound knowledge of Mathematics (Calculus), Engineering Mechanics, SOM and TOM subjects

Course Objectives:

1. To study the basic design principles
2. To familiarize with use of design data books & various codes of practice
3. To make conversant with preparation of working drawings based on designs

Course Outcomes:

After successfully completion of this course students will be able to:

1. Design shaft under various conditions
2. Design Coupling
3. Design Permanent Joints and Temporary Joints
4. Design Leaf spring
5. Convert design dimensions into working/manufacturing drawing
6. Use design data book/standard codes to standardize the designed dimensions

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Laboratory	Hours/week	No. of weeks	Total hours	Semester Credits
	02	14	28	01

Pre-requisite Course(s):

The sound knowledge of Mathematics (Calculus), Engineering Mechanics, SOM and TOM subjects

Course Objectives:

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1. design shaft under various conditions
2. design Coupling
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5. convert design dimensions into working/manufacturing drawing and use of design data book/standard codes to standardize the designed dimensions

COURSE CONTENT

Design of Machine Element Lab		Semester:	VII
Teaching Scheme:		Examination Scheme:	
Practical:	02 hours/week	End Semester Exam (ESE): oral	25 marks
		Internal Continuous Assessment (ICA):	25 Marks

Term work - Shall consist of

A. Design and detailed assembly drawing (computer aided drawing) of minimum two design problems, from the following.

1) Flexible flange coupling 2) Leaf spring 3) Spur Gear Box 4) Helical Gear Box 5) Worm Gear Box

B. Assignment: Design exercises in the form of design calculations with sketches and/ or drawings.

C. Course Project: Students in a group of two to four will be able to design and prepare working drawings (using any software) of any system having minimum 5 to 6 components by applying the knowledge gained during the course

Text Books:
1. Bhandari V.B., "Design of Machine elements", Tata McGraw Hill Pub. Co. ltd. 2. Farzdak Haideri, "Machine Design", Nirali Prakashan, Pune 3. R. B. Patil, "Mechanical System Design" Techmax publications, 4th edition (2018)
Reference Books:
1. Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Pub. Co. Ltd 2. Spott's M.F. and Shoup T.E. "Design of Machine Elements", Prentice Hall International. 3. "Design Data", P.S.G. College of Technology, Coimbatore. 4. Juvinal R.C. "Fundamental of Machine Component Design", John Wiely and sons. 5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998
Guidelines for ICA:
Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Computer Aided Design Lab

COURSE OUTLINE

Course Title:	Computer Aided Design Lab	Short Title:	CAD	Course Code:	

Course description:

The course presents the elements of solid modelling, creation of parts of increasing complexity and the assembly of parts to form a final design, along with mechanism simulation. The operation and programming of CNC machines is covered.

	Hours/week	No. of weeks	Total hours	Semester credits
Lecture	01	14	14	02
Practical	02	14	28	

Prerequisite course(s):

Fundamental knowledge about the Design and Automation of Manufacturing Process, Strength of Materials, Engineering Mechanics, etc

Course objectives:

1. To understand the concept of Computer Aided Design & Manufacturing
2. To understand the concept of Automation, F.M.S., G.T. & Robotics
3. To be familiar about CNC Programming

Course outcomes:

After successful completion of this course the student will be able to:

1. Apply the concepts of Computer Aided Design.
2. Apply the concepts of Computer Aided Graphics.
3. Apply the concepts of Computer Aided Modelling & Automation.
4. Apply the concepts of Computer Aided Manufacturing & C.N.C. Programming
5. Apply the concepts of Introduction to FMS, GT and Robotics

COURSE CONTENT

Computer Aided Design Lab		Semester:	VII
Teaching Scheme:		Examination scheme	
Lectures:	1 hours/week	End Semester Exam (ESE): Practical	25 Marks
		Internal Continuous Assessment (ICA):	25 Marks

Unit–I: Introduction To CAD/CAM and Networking — **No. of Lectures: 03 Hours**

Define CAD/CAM, Product Life Cycle & CAD/CAM, and Application of Computers for Design Process, Selection of a CAD system, Benefits & Application of CAD.

Computer communication, Principle of networking, Classification of network, Transmission media & interface, LAN system.

Unit–II: Computer Aided Graphics — **No. of Lectures: 02 Hours**

Introduction, Graphic Primitives, Point plotting, drawing of lines, Coordinate system used in graphic element, Transformation in graphics,

Homogeneous transformation, Concatenate coordinate transformation, Translation, Rotation, Scaling, Mirror, Reflection

Unit–III: Computer Aided Modeling & Automation	**No. of Lectures: 03 Hours**	
Requirement of Geometric Modeling, Geometric Model, Geometric Model Construction Method: Wire Frame Modeling, Surface Modeling, Solid Modeling Concept of Automation, Types of Automation, Advantages & limitations of Automation.		
Unit–IV: Computer Aided Manufacturing	**No. of Lectures: 03 Hours**	
Continuous control system, Discrete control system, Computer process control, Forms of CPC, Computer process Monitoring, Direct Digital Control, Manual Part Programming using G and M codes		
Unit–V: Introduction to FMS, GT and Robotics	**No. of Lectures: 03 Hours**	
FMS – Introduction, Components of FMS, Types of FMS, Application & Benefits, Typical FMS layout GT – Part families, Part classification & coding, Application of GT. Robotics – Robot Anatomy, Robot Control System, End effectors, Sensors, Industrial Robot, Application and its selection		
List of Practical's: A. Introduction to Modelling (Using any CAD software). 1. 2D drawing using sketcher- 2 Drawings 2. 3D modelling using 3D features (Modelling of any four components of any mechanical assembly) 3. Assembling and drafting (Above assembly) with proper mating conditions and interference checking. 4. Surface Modelling (Any 2 of the above components). B. Three assignments based on above syllabus. C. Study of Part programming for CNC lathe D. Study of Part programming for CNC milling machine E. Study of APT programming **ESE** **(Practical Examination)** The Practical Examination will comprise of performing the experiment and viva on the Practical's.		
Text Books:		
1. CAD/CAM & Automation by R.B. Patil, Tech- Max. Publication 2. Rao P.N., Introduction to CAD/CAM Tata McGraw Hill Publishing Co. 3. B. S. Pabla, M. Adithan, "CNC Machine ", New Age International(P) Ltd. 4. Rao, Tiwari, Kundra, "Computer Aided Manufacturing", T.M.H.		
Reference Books:		

1. Ibrahim Zeid and R. Sivasubramanian, “CAD/CAM – Theory and Practice”, Tata McGraw Hill Publishing Co. 2009
2. Ibraim Zeid, “Mastering CAD/CAM” – Tata McGraw Hill Publishing Co. 2000.
3. Groover M. P., “Automation, production systems and computer integrated manufacturing”, Prentice Hall of India
4. Yoram Koren - Robotics McGraw Hill Publishing Co.
5. James G. Keramas, Robot Technology Fundamentals, Delmar Publishers.
6. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
7. P. Radhkrishnan, S. Subramanyam, V. Raju, “CAD/CAM/CIM”, New Age Publication.
8. Mikell P. Grover, Emory W. Zimmers, “Computer Aided Design and Manufacturing”, P.H.I.
9. Zeid, “CAD/CAM”, T.M.H.

Project (Stage – I)					
LAB COURSE OUTLINE					
Course Title:	**Project (Stage – I)**	**Short Title:**	**PROJ-SI**	**Course Code:**	
Course description:					
Project represents the culmination of study towards the Bachelor of Engineering degree. The project offers the opportunity to apply and extend material learned throughout the program. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.					
Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**	
	12	**14**	**168**	**6**	
End Semester Exam (ESE) Pattern:	**Oral (OR)**				
Prerequisite course(s):					
Course objectives:					
1. To understand the basic concepts & broad principles of projects. 2. To understand the value of achieving perfection in project implementation & completion. 3. To apply the theoretical concepts to solve problems with teamwork and multidisciplinary approach. 4. To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.					
Course outcomes:					
Upon successful completion of lab Course, student will be able to:					
1. Demonstrate a sound technical knowledge of their selected project topic. 2. Undertake problem identification, formulation and solution. 3. Design engineering solutions to complex problems utilizing a systems approach. 4. Conduct an engineering project 5. Demonstrate the knowledge, skills and attitudes of a professional engineer.					
LAB COURSE CONTENT					
Project (Stage – I)		**Semester:**		**VII**	
Teaching Scheme:		**Examination Scheme:**			
Practical:	**12 hours/week**	**End Semester Exam (ESE): OR**		**50 marks**	
		Internal Continuous Assessment (ICA):		**50 marks**	
At the final year the students shall carry out a project in a group of maximum up to 5 students. The project work spans both the semesters. By the end of Semester –VII the students shall complete the partial work, and by the end of Semester –VIII the students shall complete remaining part of the project. Assessment for the project shall also include presentation by the students. Each teacher can guide maximum 04 groups of projects. The students should take project work, as specified in the curriculum, based on the knowledge acquired by the students during the degree course till Semester – VI and/or during Internship. The project may be either fully theoretical/practical or involving both					

theoretical and practical work to be assigned by the Department. The work may also be Study/Survey/Design or R&D work. The work may also be on specified task or project assigned to the students during Internship.

Project (Stage – I) may involve literature survey, problem identification, design methodology, collection of data etc. The project work shall involve sufficient work so that students get acquainted with different aspects of design and analysis. Approximately more than 50% work should be completed by the end of Semester – VII. Each student group should submit partial project report in the form of spiral bound at the end of Semester –VII. Assessment for the project shall also include presentation by the students.

Each student group is required to maintain separate log book for documenting various activities of the project.

Suggestive outline for the partial project report is as follows.

Abstract
Chapter 1. Introduction

Chapter 2. Project Planning and Management

Chapter 3. Literature Review

Chapter 4. Research Gap, Problem Statement and Objective

Chapter 5. Conclusion

Bibliography

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Appendix

Guide lines for ICA:

The Internal Continuous Assessment (ICA) for project shall be based on continuous evaluation of students' performance, active participation, knowledge / skill acquired throughout semester and presentation by the students. The assessment shall be done jointly by the guide and departmental committee. A three-member departmental committee including guide, appointed by Head of the department, shall be constituted for the assessment. The assessment for Project (Stage – I) in Semester – VII shall be as per the guidelines given in Table – A.

Table – A

		Assessment by Guide					Assessment by Departmental Committee		
Sr. No.	Name of the Student	Attendance / Participation	Problem Identification / Project Objectives	Literature Survey	Methodology / Design	Report	Depth of Understanding	Presentation	Total
	Marks	5	5	5	5	5	10	15	50

Guidelines for ESE:
In End Semester Examination (ESE), the student may be asked for presentation / demonstration and questions on Project. Evaluation will be based on answers given by students in oral examination.

Essence of Indian Traditional Knowledge					
COURSE OUTLINE					
Course Title:	**Essence of Indian Traditional Knowledge**	**Short Title:**	**EITK**	**Course Code:**	
Course description:					
Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**	
	-----	**14**	**-----**	**1**	
Prerequisite course(s):					
Course objectives:					
The course aims at imparting basic principles of thought process, reasoning and inferencing, sustainability is at the core of Indian traditional knowledge system connecting society and nature. Holistic life style of yogic science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. The course focuses on introduction to Indian knowledge systems, Indian perspective of modern scientific world-view, and basic principles of yoga and holistic health care system, Indian artistic tradition.					
Course outcomes:					
After successful completion of this course the student will be able to:					
1. understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective. 2. adopt traditional methods of Ayurveda and Yoga for happy and healthy life 3. practice classical music and dance 4. understand about ancient architecture					
COURSE CONTENT					
Essence of Indian Traditional Knowledge		**Semester:**	VII		
Teaching Scheme:		**Examination scheme**			
Lectures:	**-----**	**End semester exam (ESE):**	**----**		
		Duration of ESE:	**----**		
		Internal Sessional Exams (ISE):	**----**		
Introduction to: 1. Ayurveda, Charaka Samhita, Sushruta Samhita Principles and Terminology: Vatha, Pitha, Kapha, Ether, Earth, Water, fire and Air Tatva, Influence of these on human health. 2. Architecture: Temple Architecture, Indo – Islamic Architecture, Mughal Architecture, Indian Rock Cut Architecture, Vastu Shastra. 3. Importance of Yoga for Physical and Mental health, Yoga Sutras of Patanjali, Meditation, International day of Yoga. 4. Indian Classical Music, Hindustani and Carnatic Music, Raga, Tala, Dhrupad, Khyal, Tarana and Thumri, Sangitaratnakara, Work of Tansen, Purandara Dasa, Bhimsen Joshi, Ustad Bismillah Khan, Bal Gandharva etc. Folk Music and Dances such as Rajasthani, Marathi, Gujrati, Punjabi etc. 5. Indian Classical Dances: Shastriya Nritya, Natya Shastra, Bharatanatyam, Kathak, Kuchipudi, Odissi, Kathakali, Sattriya, Manipuri, Mohiniyattam and Chhau dance forms.					

Reference Books:

1. Amit Jha, "Traditional knowledge system in India", Atlantic Publisher, ISBN 978812691223
2. Basanta Kumar Malhotra, "Traditional Knowledge System and Technology in India", Pratibha Prakashan, ISBN 8177-023101
3. Nitin Singhania, "Indian Art and Culture", McGraw Will Publication.
4. Dr. Bramhand Tripathi, "Charak Sanhita", Chaukhambha Surbharti Prakashan, ISBN: 9381-4847-59
5. Dr. Anantram Sharma, "Sushrut Samhita"
6. Valiatham M.S., "An Introduction to Ayurveda" Orient Bkackswan Publication.
7. Valiathan M.S., "The legacy of Charaka" University Press.
8. Valiathan M.S., "The legacy of Susruta" University Press.
9. Garg Maheshwari, "Ancient Indian Architecture", CBS Publisher and Distributors
10. Sharmin Khan, "History of Indian Architecture", CBS Publisher and Distributors.
11. Bindia Thapar, Surat ku. Manto, Suparana Bhalla, "Introduction to Indian Architecture", Periplus Editions Ltd.
12. Vijay Prakash Singh, "An Introduction to Hindustani Classical Music", Lotus Publisher
13. Leeta Venkataraman, Avinash Pasricha, "Indian Classical Dance" Lustre Publisher
14. Shovana Narayan, "Indian Classical Dances" New Dawn Press
15. Kapila Vatsyayan, "Indian Classical Dance", Ministry of Information and Broadcasting, Govt of India.
16. Mahadevan Ramesh, "A Gentle introduction to Carnatic Music", Oxygen books Publisher.

Kavayatri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Bachelor of Engineering (Mechanical Engineering)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
3rd Cycle

Syllabus Structure & Contents of Fourth Year of Engineering

Semester-VIII

w.e.f. 2020 – 2021

REFRIGERATION AND AIR CONDITIONING					
COURSE OUTLINE					
Course Title:	**Refrigeration and Air Conditioning**	**Short Title:**	**RAC**	**Course Code:**	

Course Description:

This course familiarizes under graduate students with the terminologies associated with Refrigeration and Air-conditioning. The course will help students to understand phenomenon of refrigeration with basic properties of refrigerants and build student's ability to solve refrigeration problems. The course also includes basic principles of psychrometry, applied psychometrics and study of different air conditioning system such air windows Air-conditioning and use of Psychrometric chart to study the behavior of moist air at different conditions.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester Credits**
	3	**14**	**42**	**3**

Pre-requisite Course(s):

Applied Physics, Fundamentals of Thermodynamics

Course Objectives:

1. To familiarize with the terminology associated with refrigeration systems and air conditioning.
2. To understand basic refrigeration processes.
3. To learn about the basics of psychrometry and practice of applied psychometrics.
4. To acquire the skills required to model, analyze and design different refrigeration as well as air conditioning processes and components.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Understand the principles of refrigeration and remember the application of air refrigeration.
2. Learn the working of single stage, multistage and Multi-Evaporator using vapour compression refrigeration system with different type of refrigerants.
3. Study the working principles and its application of vapor absorption refrigeration system.
4. Apply the knowledge of psychrometry to various psychrometric processes in Air-conditioning system.
5. Learn different types of Air-Conditioning system used for Human comfort and Use P-h, T-S and Psychometric charts to solve refrigeration and Air conditioning design problems.

COURSE CONTENT

Refrigeration and Air Conditioning		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I: Refrigeration Systems	**No. of Lectures: 08 hours**	**Marks: 12**

Introduction, Need of Refrigeration, Standard Rating of Refrigerating Machine, Coefficient of Performance of Refrigerator and Heat Pump, Classification of Refrigeration Systems, Air

Refrigeration - Reversed Carnot Cycle and Its Limitation, Bell-Coleman Cycle, Merits and Demerits of Air Refrigeration, Need of Aircraft Refrigeration, Working and Analysis of aircraft Refrigeration Systems.		
Unit – II: Vapour Compression Refrigeration System	**No. of Lectures: 10 hours**	**Marks: 12**
Working of Simple Vapour Compression System, System Components: Classification of Compressors, Condensers, Expansion Devices and Evaporators. Representation of Theoretical Vapour Compression Cycle (VCC) On T-S And P-H Diagram, Effect of Superheating and Subcooling, Use of Refrigeration Table and Chart, Actual Vapour Compression Cycle, Compound Vapour Compression System with Inter Cooling, Flash Chamber and Multi Evaporators Systems, Refrigerants and Their Mixtures: Designation, Properties and Characteristics, Ozone Depletion and Global Warming Issues.		
Unit – III: Vapour Absorption Refrigeration Systems	**No. of Lectures: 07 hours**	**Marks: 12**
Simple & Practical Vapour Absorption Refrigeration Systems, COP of Vapour Absorption Refrigeration Systems, Desirable Properties of Absorbent-Refrigerant Combinations, Electrolux Refrigerator, Lithium-Bromide Refrigeration System, Enthalpy Concentration (H-C) Charts, Analysis of Aqua -Ammonia Refrigeration System Using H-C Chart.		
Unit – IV: Psychrometry	**No. of Lectures: 08 hours**	**Marks: 12**
Psychrometric - Properties of Moist Air, Sling Psychrometers, Psychrometric Relations, Psychrometric Chart, Basic Psychrometric Processes, Bypass Factor, Sensible Heat Factor, Concept of Enthalpy Potential – Air Washers, Evaporative Condensers, Cooling and Dehumidifying Coils. Adiabatic Mixing of Air Stream.		
Unit – V: Air Conditioning System	**No. of Lectures: 09 hours**	**Marks: 12**
Comfort Chart, Classifications of Air-Conditioning Systems, Summer, Winter and Year-Round Air Conditioning, Window and Central Air Conditioning Systems, Applications of AC Systems, Room Sensible Heat Factor (RSHF), Grand Sensible Heat Factor GSHF, Effective Room Sensible Heat Factor (ERSHF), Cooling Load Estimation - Components of Cooling Loads.		
Text Books:		
1. Khurmi Gupta, “Refrigeration and Air- Conditioning”, S Chand, New Delhi. 2. Monohar Prasad, "Refrigeration and air conditioning”, New Age Publishers, New Delhi. 3. Arora and Domkundawar, “Refrigeration and air conditioning”, Dhanpatrai and Sons, New Delhi.		
Reference Books:		
1. Arora C. P., "Refrigeration and air conditioning”, TMH, New Delhi. 2. Ananthnarayanan, "Basics of Refrigeration”, TMH, and New Delhi. 3. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982. 4. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986. 5. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.		

ROBOTICS					
COURSE OUTLINE					
Course Title:	**Robotics**	**Short Title:**	**RBT**	**Course Code:**	
Course Description:					
This course is aimed to provide exposure on the Robot anatomy, sensors, kinematics, applications and problems associated with their design.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester Credits**
	3	**14**	**42**	**3**

Pre-requisite Course(s):

Fundamental knowledge of Mathematics, Automation, Mechatronics.

Course Objectives:

1) To understand the basic concepts associated with the robot functioning and applications of Robots.
2) To study about the robot motion analysis of robot.
3) To study about the drives and control system used in Robots.
4) To understand the concepts of end effectors, sensors and vision system used in robots
5) To learn about robot programming

Course Outcomes:

After successfully completion of this course students will be able to:

1) To know about fundamental knowledge about the robot
2) To know about robot motion analysis
3) To know about drives and control system used in robots.
4) To know about end effectors, sensors and vision system.
5) To know about robot programming methods and languages.

COURSE CONTENT

Robotics		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	**No. of Lectures: 09 hours**	**Marks: 12**

BASIC CONCEPT IN ROBOTICS

Historical perspective of robot, definition of robot, need of robots, classification of robot, automation and robotics, robot anatomy, basic structure of robotics. resolution, accuracy and repeatability, Classification of configuration of robot, point to point and continuous system, control loop of robotics system, Points considered for Selection of Robot, Degree of Freedom of robot, comparison of the human and robot manipulator, Robot joints, Application of robot.

Unit – II:	**No. of Lectures: 09 hours**	**Marks: 12**

ROBOT MOTION ANALYSIS

Introduction, Robot arm kinematics, Transformations, rotation matrix, geometric interpretation of rotation matrix, inverse transformation, composite transformation, Kinematics chain, Forces encountered in Moving coordinate systems Lagrange's Analysis of Manipulator.

Unit – III:	**No. of Lectures: 08 hours**	**Marks: 12**

DRIVES AND CONTROL SYSTEM

Robot drive system, Hydraulic system for robot, Pneumatic actuators, Electric drives DC servo motor, AC servo motor, stepper motor, Robot activation and feedback component, positional and velocity sensors. power transmission system, Application of robot.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
END EFFECTORS, SENSORS AND VISION SYSTEMS		
End Effectors Types of end effectors, mechanical grippers, vacuum, magnetic, adhesive grippers, tools as end effectors, Gripper selection and design, force analysis of gripper mechanism, Introduction to Sensors: Need of sensors in a robotic system, selection of sensors, classification of sensor, photo sensors, limit switches. Range sensors, force/ torque sensors, proximity sensors, touch sensors, tactile sensors. VISION SYSTEMS: concept of low level and high-level vision in a robotic system.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
ROBOT PROGRAMMING		
Methods of robot programming, On line Programming, Teach Pendant Programming, Walk through Programming, off line programming and lead through programming methods, a robot program as a path in space. Motion interpolation WAIT, SIGNAL, AND DELAY commands. ROBOT LANGUAGES: The textural robot languages, generation of robot programming languages, robot language structure, constant, variables and other. data objects, motion commands, end effector and sensor commands		
Text Books:		
1.Industrial Automation and Robotics by A. K. Gupta & S. K. Arora 2. Industrial Robotics by Ganesh S. Hedge 3. CAD/CAM & Automation by R. B. Patil		
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" 5) Niku, "Introduction to Robotics: Analysis System and Application", Pearson Education		

3D PRINTING					
COURSE OUTLINE					
Course Title:	**3D Printing**	**Short Title:**	**3DP**	**Course Code:**	

Course Description:

3D printing refers to the manufacturing process that additively forms or creates a physical object from a digital design. There are various 3D printing technologies and materials, and all are based on the same principle that, a digital model is reshaped to the solid three-dimensional object by adding layer after the layer.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Engg. Drawing, Manufacturing Technology, Material Engg.

Course Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Develop CAD models for 3D printing.
2. Import and Export CAD data and generate .stl file.
3. Select a specific material for the given application.
4. Select a 3D printing process for an application.
5. Produce a product using 3D Printing or Additive Manufacturing (AM)

COURSE CONTENT

3D Printing		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	No. of Lectures: 08 hours	Marks: 12

3D Printing (Additive Manufacturing)

Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format.

Unit – II:	No. of Lectures: 08 hours	Marks: 12

Additive Manufacturing Techniques:
i) Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.
ii) Process, Process parameter, Process Selection for various applications.
iii) Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools.

Unit – III:	**No. of Lectures: 09 hours**	**Marks: 12**

Materials:
i) Polymers, Metals, Non-Metals, Ceramics
ii) Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
iii) Support Materials

Unit – IV:	**No. of Lectures: 09 hours**	**Marks: 12**

Additive Manufacturing Equipment:
i) Process Equipment- Design and process parameters
ii) Governing Bonding Mechanism
iii) Common faults and troubleshooting
iv) Process Design

Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**

1. Post Processing: Requirement and Techniques
2. Product Quality:
i) Inspection and testing
ii) Defects and their causes

Text Books:

1. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
2. Kalani Kirk Hausman, Richard Horne, "3D Printing For Dummies", 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey

Reference Books:

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
3. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
4. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.
5. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
6. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012.

RENEWABLE ENERGY SOURCES & TECHNOLOGY					
COURSE OUTLINE					
Course Title:	**Renewable Energy Sources & Technology**	**Short Title:**	**REST**	**Course Code:**	

Course Description:

This course looks at the operating principle of a range of non-conventional energy resources, materials used, characterization, and key performance characteristics. The technologies looked at will include, Solar energy, Wind, Batteries, Fuel cells, and Geothermal conversion.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Physics, Basics of Electrical Engg., Material Engg.

Course Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Course Outcomes:

After successfully completion of this course students will be able to:

1. describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
2. appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
3. understand the concept of Biomass energy resources and their classification, types of biogas plants- applications
4. acquire the knowledge of wave power & tidal power
5. acquire the knowledge of fuel cells & hydrogen energy

COURSE CONTENT

Renewable Energy Sources & Technology		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	No. of Lectures: 09 hours	Marks: 12

Solar Energy:

Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers,

storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaics - solar cells & its applications		
Unit – II:	**No. of Lectures: 08 hours**	**Marks: 12**
Wind Energy: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations		
Unit – III:	**No. of Lectures: 09 hours**	**Marks: 12**
Energy from Biomass: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Energy from the ocean: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Fuel Cells: Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells. Hydrogen Energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.		
Text Books:		
1. G.D. Rai, “Non-conventional energy sources”, Khanna Publishers, Delhi. 2. B. L. Singhal, “Alternative Energy Sources”, Tech Max Publication, Pune.		
Reference Books:		
1. S.Hasan Saeed and D.K.Sharma, “Non-Conventional Energy Resources”, Katson Books. 2. Duffic and Beckman, “Solar Engineering of Thermal Processes”, John Wiley, New Delhi. 3. H.P. Garg & Jai Prakash, “3Solar Energy: Fundamentals and Applications”, Tata McGraw Hill, Delhi.		

Design of Transmission Systems					
COURSE OUTLINE					
Course Title:	**Design of Transmission Systems**	**Short Title:**	*DTS*	**Course Code:**	
Course description:					
The course aims of imparting the knowledge of Transmission Systems. The background required includes knowledge of Physics, Engineering Maths, Kinematics and Theory of Machines. The objective of the course is to understand the Transmission Systems concept, gear design and its application.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	3	**14**	**42**	**3**

Prerequisite course(s):
Fundamental Knowledge of Physics, Engineering Maths, Kinematics and Theory of Machines
Course objectives:
1. To learn about the design procedures for mechanical power transmission components 2. To understand the standard procedure available for Design of Transmission of Mechanical elements 3. To learn to use standard data and catalogues.
Course outcomes:
After successful completion of this course the student will be able to:
1. Apply the concepts of design to belts, chains and rope drives. 2. Apply the concepts of design to spur, helical gears. 3. Apply the concepts of design to worm and bevel gears. 4. Apply the concepts of design to gear boxes. 5. Apply the concepts of design to cams, brakes and clutches.
COURSE CONTENT

Design of Transmission Systems		**Semester:**	**VIII**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I: Flexible Transmission Elements	**No. of Lectures: 08 Hours**	**Marks: 12**
Design of Flat Belts & Pulleys, Selection of V-Belts and Pulleys, Selection of Hoisting Wire Ropes and Pulleys, Design of Chains and Sprockets		
Unit–II: Gear Transmission	**No. of Lectures: 08 Hours**	**Marks: 12**
Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears.		
Unit–III: Straight Bevel Gear	**No. of Lectures: 08 Hours**	**Marks: 12**

Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears; Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears.

Unit–IV: Gear box	**No. of Lectures: 09 Hours**	**Marks: 12**

Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine tool applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications.

Unit–V: Design of Cam, Clutches & Types of Brakes	**No. of Lectures: 09 Hours**	**Marks: 12**

Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internal expanding shoe brake.

Text Books:

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001
4. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.

Reference Books:

1. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.
2. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
3. C.S.Sharma, Kamlesh Purohit, "Design of Machine Elements", Prentice Hall of India, Pvt. Ltd., 2003.
4. Bernard Hamrock, Steven Schmid, Bo Jacobson, "Fundamentals of Machine Elements", 2nd Edition, Tata McGraw-Hill Book Co., 2006.
5. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005
6. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum"s Outline), 2010
7. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
8. Ansel Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
9. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Printice Hall, 2003.

TOTAL QUALITY MANAGEMENT

COURSE OUTLINE

Course Title:	Total Quality Management	Short Title:	TQM	Course Code:	

Course Description:

This course exposes participants to contemporary knowledge and techniques of TQM. This would in turn enable the participant to articulate and implement quality improvement processes in the workplace, in line with the philosophy of Total Quality Management.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Quality Control.

Course Objectives:

To give the students an overview of quality and TQM and explaining the salient contributions of Quality Gurus like Deming, Juran and Crosby. General barriers in implementing TQM.

Course Outcomes:

After successfully completion of this course students will be able to:

1. Implement the principles and concepts inherent in a Total Quality Management (TQM) approach to managing a manufacturing or service organization.
2. Understand the philosophies--including similarities and differences--of the gurus of TQM in order to better evaluate TQM implementation proposals offered by quality management organiza-tions and consultants.
3. Utilize Statistical Process Control (SPC) techniques as a means to diagnose, reduce and eliminate causes of variation.
4. Apply various quality improvement techniques.
5. Successfully implement process improvement teams trained to use the various quality tools for identifying appropriate process improvements & assess exactly where an organization stands on quality management with respect to the ISO 9000 quality management standard.

COURSE CONTENT

Total Quality Management		Semester:	VIII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I:	No. of Lectures: 09 hours	Marks: 12

Introduction to Quality Management:

Definitions – TOM framework, benefits, awareness and obstacles. Quality – vision, mission and policy statements. Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.		
Unit – II:	**No. of Lectures: 08 hours**	**Marks: 12**
Principles & Philosophies of Quality Management: Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle, Japanese 5S principles and 8D methodology.		
Unit – III:	**No. of Lectures: 09 hours**	**Marks: 12**
Statistical Process Control & Process Capability: Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed. Process capability – meaning, significance and measurement – Six sigma concepts of process capability. Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve. Total productive maintenance (TMP) – relevance to TQM, Terotechnology. Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Tools & Techniques for Quality Management: Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation. Seven old (statistical) tools. Seven new management tools. Bench marking and POKA YOKE.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Quality Systems organising & Implementation: Introduction to IS/ISO 9004:2000 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward- Introduction to software quality.		
Text Books:		
1. Janakiraman. B and Gopal. R. K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006. 2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006. 3. Ramasamy Subburaj, "Total Quality Management", Mc Graw Hill, New Delhi.		
Reference Books:		
1. Dale H.Besterfield et al, Total Quality Management, Third edition, Pearson Education, (First Indian Reprints 2004). 2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.		

3. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 8th Edition, First Indian Edition, Cengage Learning, 2012.
4. ISO 9001-2015 standards

AUTOMOBILE ENGINEERING					
COURSEOUTLINE					
Course Title:	**Automobile Engineering**	**Short Title:**	**AE**	**Course Code:**	

Course Description:

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester Credits**
	03	14	42	03

Pre-requisite Course(s):

I. C. Engines, Theory of Machines, Basics of Electrical and Electronics

Course Objectives:

1. To develop competencies in performance analysis of vehicles
2. To provide insight into the electrical systems of an automobile
3. To familiarize with the latest technological developments in automotive technology
4. To make the student conversant with vehicle maintenance.
5. To understand the emerging trends of electric vehicles, hybrid electric vehicles and solar vehicles.

Course Outcomes:

After successfully completion of this course students will be able to:
1. To compare and select the proper automotive system for the vehicle.
2. To analyse the performance of the vehicle.
3. To diagnose the faults of automobile vehicles.
4. To apply the knowledge of EVs, HEVs and solar vehicles
5. Demonstrate the working of different types of final drives, steering gears and braking systems

Illustrate the constructional features of wheels, tyres and suspension systems

COURSE CONTENT

Automobile Engineering		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I: Introduction to Automobile	**No. of Lectures: 08 hours**	**Marks: 12**

Introduction to Automobile, History of Automobile, Types of Automobile, Automobile Industry, Special Purpose Vehicle.

Chassis: Classification of Chassis, Integral and Chassis less Construction, **Frame**, Functions of the frame, Types of the Frame, Defects in Frame, Sub Frame,

Body Automobile Wheels, Tyres: Introduction, Wheel Assembly, Wheel and Tyre Sizes, Types of wheels, Wheels balance, Rims, Tyres, Types of tyres, Tyres Construction and Constituents, Tyres thread Patterns, Load Ratings, Tyres Selections and Tyre Properties, Tyres Pressure and wear, Causes of Tyre Wear, Tyre size, Tyres maintenance, Factors increase life of tyre

Brake: Braking Requirements, Function of the brakes, Classification of the brakes b Hydraulic Brakes, Power Brakes, Air Brakes, Brake Efficiency & Stopping Distance, Factor Controlling the Stop of an Automobile, Brake Lining, Brake Testing & Testers, Brake Service		
Unit – II: Automobile Suspension	**No. of Lectures: 08 hours**	**Marks: 12**
Automobile Suspension: Function of Suspension system, Requirements of a Suspension System, Torque Rod, Stabilizer Bar, Air Suspension, Hydraulic Suspension, Types of Suspension Spring, Plastic springs for motor cars, Shackle, Shock Absorber, Front Axle Suspension System, Rear Suspension System, Spring and Suspension trouble shooting chart **Automobile Steering:** Introduction, Principle of Correct Steering, Requirements of steering system, Steering system functions , General arrangement of steering system, Steering gears and linkages , Power steering, Reversible and irreversible steering, Factor Affecting understeering and over-steering , 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		
Unit – III: Automobile Transmission	**No. of Lectures: 09 hours**	**Marks: 12**
Clutch: Introduction., Clutch and its functions, Principles of Operations, Requirement of Clutch, Main Parts of clutch, Types of friction materials, Properties of good clutch lining, Types of clutches, Clutch Maintenance, Clutch troubles and their causes Factors Affecting the Power Transmitted by the Clutch, Propeller Shaft, Universal Joint, Rear Axle. **Gear Box:** Necessity of gear box. Sliding mesh, Constant mesh, and Synchromesh Gear selector mechanisms. Overdrives and hydrodynamic torque converter, Trouble shooting and remedies. **Propeller Shaft and Axle**: Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints Types of live axles; semi, three quarter and full floating axles Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine and Reverse Lamoine.		
Unit – IV: Automobile Electrical system and Air Conditioning	**No. of Lectures: 09 hours**	**Marks: 12**
Introduction to Starting System, Lead-Acid Battery, Recharging of Battery, Charging procedure, Battery voltage, Battery Capacity, Battery Rating, Battery Life, Factors affecting Battery life, Battery testing, Battery troubles b Introduction to Ignition System-Types, Introduction Charging System, Spark Plug Introduction To Wiring System, Standard Color coding, Tracking faults in wiring, Functioning of the Electrical system in an Automobile, Improvement in Electrical system in an Automobile. Air Conditioning System Refrigerant, Conventional Heating and Ventilation, Air Distribution Parts, Automatic Climate Control, Automatic Temperature Control System, Air Conditioning Troubleshooting, Heating System Troubleshooting		
Unit – V: Electric & Hybrid Electric Vehicles	**No. of Lectures: 08 hours**	**Marks: 12**
Introduction: Concept and environmental importance of EVs, HEVs and solar vehicles. Electric vehicles: Layout, construction and working. Hybrid electric vehicles: Types, layout, hybridization factor, plug in hybrid electric vehicles, fuel efficiency analysis. Challenges and future scope of EVs and HEVs.		

Text Books:

1. K. Newton, W. Seeds, T.K. Garrett, "Motor Vehicle", 13th Edition, Elsevier publications.
2. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering", SAE Publications.
3. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.
4. Joseph Heitner, "Automotive Mechanics", C.B.S Publishers and Distributors.
5. SAE Manuals and Standards.
6. N. K. Giri, "Automobile Mechanics".
7. P. S. Kohali, "Automobile Electrical Equipment", Tata McGraw Hill Publishing House.
8. Narang G. B. S, "Automobile Engineering", S. Chand and Company Ltd.

Reference Books:

1. Dr. Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers distributors.
2. Crouse/Anglin "Automobile Mechanics", Tata Mcgraw-Hill.
3. R. B. Gupta, Automobile Engineering, Satya Prakashan
4. Chris Mi, M. Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Willey.
5. Electric and Hybrid Vehicles, Tom Denton, Routledge.
6. Hybrid Electric Vehicle Technology, Automotive Research and Design, American Technical.
7. Husain, Iqbal, Electric and hybrid vehicles, 2nd edition, CRC Press.
8. Ron Hodkinson and John Fenton, Butterworth-Heinemann. Lightweight Electric/ Hybrid Vehicle Design.
9. Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Standards media.

COMPUTATIONAL FLUID DYNAMICS

COURSE OUTLINE

Course Title:	Computational Fluid Dynamics	Short Title:	CFD	Course Code:	

Course Description:

This course familiarizes under graduate students with the terminologies associated with computational fluid dynamics. The course will help students to understand phenomenon of computational fluid dynamics and build student's ability to solve computational fluid dynamics problems. The course also includes governing equation and Finite volume methods with discretization. Students will also familiarize with computational fluid dynamics tools to solve industrial problems.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Thermodynamics, Applied Thermodynamics, Fluid Mechanics

Course Objectives:

1. To develop an understanding for the major theories, approaches and methodologies used in CFD.
2. To understand techniques used in computational fluid dynamics
3. To do discretize the governing equations by Finite Difference Method and Finite Volume Method.
4. To build up the skills in the actual implementation of CFD methods.
5. Students should be able to model fluid / heat transfer problems and apply fundamental conservation principles.

Course Outcomes:

After successfully completion of this course students will be able to:
1. comprehend the methodology of computational fluid dynamics (CFD).
2. understand and be able to numerically solve the governing equations for fluid flow.
3. understand and apply finite difference, finite volume and finite element methods to fluid flow problems.
4. understand how grids are generated.
5. ability to use a CFD tool effectively for practical problems and research

COURSE CONTENT

Computational Fluid Dynamics		Semester:	VIII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I: Introduction to CFD	No. of Lectures: 09 hours	Marks: 12

Introduction to Computational Fluid Dynamics (CFD) – a research and design tool, CFD as third dimension of engineering supplementing theory and experiment, steps in CFD solution procedure, strengths and weakness of CFD, Types of fluids, basic concepts in laminar and turbulent flows, Laws governing fluid motion, continuity, Navier – stokes & energy equations. Exact solutions of N-S equations, Physical interpretation of governing equations and boundary conditions.		
Unit – II: Grid Generation	**No. of Lectures: 08 hours**	**Marks: 12**
Transformation of coordinates. General principles of grid generation – structured grids in two and three dimensions, algebraic grid generation, differential equations-based grid generation; Elliptic grid generation, algorithm, Grid clustering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. Techniques for complex and large problems: Multi block methods.		
Unit – III: Finite Difference Discretization	**No. of Lectures: 09 hours**	**Marks: 12**
Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis. Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property, higher order up winding. Finite difference applications in heat transfer – conduction, convection.		
Unit – IV: Finite Volume Method	**No. of Lectures: 08 hours**	**Marks: 12**
Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretized equations using TDMA. Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Finite Element Method: Introduction. Weighted residual and variational formulations. Interpolation in one-dimensional and two-dimensional cases.		
Unit – V: CFD as Practical Approach	**No. of Lectures: 08 hours**	**Marks: 12**
Introduction to any CFD tool, steps in pre-processing, geometry creation, mesh generation, selection of physics and material properties, specifying boundary condition, Physical Boundary condition types such as no slip, free slip, rotating wall, symmetry and periodic, wall roughness, initializing and solution control for the solver, Residuals, analyzing the plots of various parameters (Scalar and Vector contours such as streamlines, velocity vector plots and animation). Introduction to turbulence models. Reynolds Averaged Navier-Stokes equations (RANS), k-ϵ .		
Text Books:		
1. John D Anderson, “Computational Fluid Dynamics: The Basics with Applications”, Mc Graw Hill. 2. Versteeg, H. K. & W. Malalasekera, " An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Pearson Education, Ltd. 3. Atul Sharma, “Introduction to Computational Fluid Dynamics: Development, Application and Analysis”, Wiley.		
Reference Books:		
1. A. W. Date, “Introduction to Computational Fluid Dynamics”, Cambridge University Press, India.		

2. J. Tu, G.-H. Yeoh and C. Liu. “Computational Fluid Dynamics: A practical approach”, Elsevier.
3. Ferziger J. H., Springer P.M, “Computational Methods for fluid Dynamics”, Verlag Berlin.
4. T. J. Chung, “Computational Fluid Dynamics”, Cambridge University Press.
5. Sunderarajan M.K., “Computational Fluid Flow and Heat Transfer”, 2nd Ed, Narosa Publishing.
6. Suhas V. Patankar, “Numerical Heat Transfer and Fluid Flow”, Hemisphere Publishing Corporation.

GAS DYNAMICS AND JET PROPULSION

COURSE OUTLINE

Course Title:	Gas Dynamics & Jet Propulsion	Short Title:	GDJP	Course Code:	

Course Description:

The course aims at imparting knowledge of modes of Gas Dynamics and Jet Propulsion & its application. It includes compressible flow, its concept and flow through ducts. It also contains concepts of the normal , oblique shocks , jet propulsion and rocket propulsion.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Thermodynamics, Applied Thermodynamics, Fluid Mechanics

Course Objectives:

1. To understand the features of compressible isentropic flows and irreversibility's like shocks.
2. To provide a basic knowledge of jet and rocket propulsion technologies.

Course Outcomes:

After successfully completion of this course students will be able to:
1. apply the concept of compressible flows and momentum energy equation.
2. apply the concept of isentropic flow variable area ducts.
3. to understand the concept of Non-isentropic in constant area ducts.
4. use the concept of gas dynamics in Jet Propulsion.
5. apply the concept of gas dynamics in Space Propulsion.

COURSE CONTENT

Gas Dynamics & Jet Propulsion		Semester:	VIII
Teaching Scheme:		Examination Scheme:	
Lectures:	3 hours/week	End Semester Exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit – I:	No. of Lectures: 09 hours	Marks: 12

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow.

Unit – II:	No. of Lectures: 08 hours	Marks: 12

Isentropic flow through variable area ducts, nozzles and diffusers, subsonic and supersonic flow, variable area ducts, choked flow, Area-Mach number relations for isentropic flow.

Unit – III:	No. of Lectures: 09 hours	Marks: 12

Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights.		
Text Books:		
1. Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill, 2003. 2. Yahya, S.M. "Fundamentals of Compressible Flow", New Age International (P) Limited, NewDelhi, 1996. 3. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008 4. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing. 5. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley. 6. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975. 7. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1988		
Reference Books:		
1. Hill. P. and C. Peterson, "Mechanics and Thermodynamics of Propulsion", Addison – WesleyPublishing company, 1992. 2. Zucrow. N.J., "Aircraft and Missile Propulsion", Vol.1 & II, John Wiley, 1975. 3. Zucrow. N.J., "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York. 4. Sutton. G.P., "Rocket Propulsion Elements", John wiley, New York, 1986. 5. Shapiro. A.H.," Dynamics and Thermodynamics of Compressible Fluid Flow", John wiley, NewYork, 1953. 6. Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 1999. 7. Somasundaram. PR.S.L.,"Gas Dynamics and Jet Propulsions”, New Age International Publishers, 1996. 8. Babu. V., "Fundamentals of Gas Dynamics", ANE Books India, 2008. 9. Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", Longman Group Ltd.,1980.J		

ENTREPRENEURSHIP, INNOVATIONS & STARTUPS					
COURSE OUTLINE					
Course Title:	**Entrepreneurship, Innovations & Startups**	**Short Title:**	**EIS**	**Course Code:**	

Course Description:

This course is a comprehensive "deep dive" into the crucial law-sensitive issues faced in the launching, financing, growing, and selling or winding down a new venture.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Communication Skills

Course Objectives:

1. Understanding the concept and process of entrepreneurship - its contribution in and role in the growth and development of individual and the nation
2. Acquiring entrepreneurial quality, competency and motivation
3. Learning the process and skills of creation and management of entrepreneurial venture

Course Outcomes:

After successfully completion of this course students will be able to:

1. Understand the meaning and define a startup
2. Understand the meaning and triggers of idea generation
3. Understand the values, attitudes and motivation required by an Entrepreneur
4. Understand and apply the concept of Business Plan
5. Understand the methods of raising finance in primary market & the importance of secondary market for mobilization or resources

COURSE CONTENT

Entrepreneurship, Innovations & Startup		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	**No. of Lectures: 09 hours**	**Marks: 12**

Business Models & Intellectual Property:

The Creative Process: Ideation, management of innovation, design thinking based on a particular technology.

Opportunity Identification and Research– opportunity seeking and identification, feasibility analysis, business model development, and understanding the needs of the customer and the market.

Strategy, Planning & Team Building – forming a venture or project team, introduction to creating business plans, legal and financial issues of starting and maintaining a new venture, strategic planning for a new product, issues around the commercialization of intellectual property and new technology transfer models.		
Unit – II:	**No. of Lectures: 08 hours**	**Marks: 12**
Design Thinking for Innovation: Structuring and Packaging a Commercial idea – The value propositions, sustainable positioning, competitive advantage, presenting the idea in multiple formats, formulating new product development timelines and analysing strategic options. Integrating Continuous Feedback and Communicating Concepts to Different Audiences – Obtaining and integrating key feedback from multiple mentors, constantly adjusting the relevant information into a variety of communications options and to ability to identify relevant gaps.		
Unit – III:	**No. of Lectures: 09 hours**	**Marks: 12**
Entrepreneurship: Introduction to Entrepreneurship: Meaning and concept of entrepreneurship, the history of entrepreneurship development, role of entrepreneurship in economic development, agencies in entrepreneurship management and future of entrepreneurship. The Entrepreneur: Meaning of entrepreneur, the skills required to be an entrepreneur, the entrepreneurial decision process, and role models, mentors and support system		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Technology & Innovation Management: Business Opportunity Identification: Business ideas, methods of generating ideas, and opportunity recognition. Preparing a Business Plan: Meaning and significance of a business plan, components of a business plan, and feasibility study Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property, and marketing the new venture.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Venture Capital & Growth Finance: Financing the New Venture: Importance of new venture financing, types of ownership securities, venture capital, types of debt securities, determining ideal debt-equity mix, and financial institutions and banks Managing Growth in New Venture: Characteristics of high growth new ventures, strategies for growth, and building the new venture capital Harvesting Rewards: Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy.		
Text Books:		
1. Drucker, P. F. Innovation and Entrepreneurship: Principles and Practice 2. Ries, E. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses 3. Muthu Singaram, "Entrepreneurship: A hands on guide to starting your business" 4. Prathistha Jain, Muthu Singaram, "Greenfields: Building a Stronger Ecosystem for Start-Ups and Entrepreneurs: Suggested Standard Operating Procedures for Incubators".		

Reference Books:
1. Osterwalder, A. and Pigneur, Y., "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers". 2. Thiel, P., "Zero to One: Notes on Startups, or How to Build the Future" 3. Christenson, Clayton, "The Innovator's Dilemma",

INDUSTRIAL AND SYSTEM ENGINEERING					
COURSE OUTLINE					
Course Title:	**Industrial & System Engineering**	**Short Title:**	**ISE**	**Course Code:**	

Course Description:

This course gives idea about how to prepare job plan, work study for productivity improvement and different aspect of production planning and control. Systems engineering utilizes an inter-disciplinary problem-solving approach across the entire technical effort. This course will provide an overview of both theory and practice of the systems engineering discipline along with systems engineering design approach.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Communication Skills

Course Objectives:

1. It focuses on systems of people, money, knowledge, information, equipment, energy, and materials and may address mathematical, physical and social science concerns.
2. To equip students with capability to develop system solutions that optimally fulfil customer objectives with available resources.

Course Outcomes:

After successfully completion of this course students will be able to:

1. solve forecasting problem by applying different techniques & understand planning, scheduling and sequencing problems for shop floor.
2. apply work study techniques and understands its importance for better productivity.
3. demonstrate wage and incentive plans & acquire knowledge of industrial legislation.
4. create know-how on solving open-ended problems, utilizing creativity, problem formulation & generation of need statements.
5. apply various realistic aspects such as safety, reliability, manufacturability, operations, aesthetics, ethics and sustainability.

COURSE CONTENT

Entrepreneurship, Innovations & Startsup		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	**No. of Lectures: 09 hours**	**Marks: 12**

Types of Production systems and their Characteristics, functions and objectives of Production Planning and Control, Sales forecasting: Techniques and Applications, Steps of

Production Planning and Control: Process planning, Leading, Scheduling, Dispatching and Expediting with illustrative examples, Introduction to line of balance, assembly line balancing and progress control.		
Unit – II:	**No. of Lectures: 09 hours**	**Marks: 12**
Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity – concepts and measurements; method study, micro-motion study, principles of motion economy; work measurement – time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes and wage administration.		
Unit – III:	**No. of Lectures: 08 hours**	**Marks: 12**
Objective, Methods of job evaluation, job evaluation procedure, merit rating (Performance appraisal), method of merit rating, wage and wage incentive plans. Need for Industrial legislation, Factories act 1948, Industrial dispute act 1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952.		
Unit – IV:	**No. of Lectures: 08 hours**	**Marks: 12**
Systems engineering – what is, origin, and examples, Systems engineering as a profession, Power of systems engineering and examples, Systems engineering viewpoint, perspectives, domains, Systems engineering fields, approaches, activities, and products. Complex system structure-building blocks, hierarchy, interfaces; Complex system structure-environment, interactions, complexity; System development process – life cycle, evolutionary characteristics; Systems engineering method; Systems testing throughout development.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Managing systems development, risks, work break down structure (WBS), systems engineering management plan (SEMP); Systems risk management, organizing for systems engineering, Need analysis – originating, operations, functional and feasibility; Need validation, systems ops requirement; System requirements development, performance requirements. Implementing concept exploration, validating requirements; Concept definition – selection and validation, functional analysis and allocation; Systems architecture, system modelling languages, Model-Based Systems Engg (MBSE).		
Text Books:		
1. R. Panneerselvam, "Production and Operations Management", PHI Private Ltd., 2. Martand Telsang, "Industrial Engineering and Production Management", S Chand & company. 3. Banga and Sharma, "Industrial Engineering and Production Management" Khanna Publishers. 4. Dr. B. Kumar, "Industrial Engineering and Management", Khanna Publishers 5. "Work study", International Labour Organisation, ILO		
Reference Books:		

1. Harold Amrine, John Ritchey, Moodie, Kmec "Manufacturing Organisation & Management", 6th Ed., Pearson
2. Production System, Planning, Analysis and Control – By J.L. Riggs 3rd ed. Wiley

INTERNET OF THINGS					
COURSE OUTLINE					
Course Title:	**Internet of Things**	**Short Title:**	**IOT**	**Course Code:**	

Course Description:

3D printing refers to the manufacturing process that additively forms or creates a physical object from a digital design. There are various 3D printing technologies and materials, and all are based on the same principle that, a digital model is reshaped to the solid three-dimensional object by adding layer after the layer.

Lecture	Hours/week	No. of weeks	Total hours	Semester Credits
	3	14	42	3

Pre-requisite Course(s):

Engg. Drawing, Manufacturing Technology, Material Engg.

Course Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Course Outcomes:

After successfully completion of this course students will be able to:
1. understand the design principles for connected devices
2. understand the design principles of Internet connectivity
3. analyze the concepts of knowledge acquiring, managing and storing
4. understand the wide variety of sensors
5. design the software for IoT applications

COURSE CONTENT

Internet of Things		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit – I:	**No. of Lectures: 08 hours**	**Marks: 12**

Internet of Things: An Overview: Internet of Things, IoT Conceptual Framework, IoT Architectural View, Technology Behind IoT, Sources of IoT, M2M Communication, Examples of IoT.

Design Principles for Connected Devices: IoT/M2M Systems Layers and Designs Standardization, Communication Technologies, Data Enrichment, Data Consolidation and Device Management at Gateway, Ease of Designing and Affordability.

Unit – II:	**No. of Lectures: 08 hours**	**Marks: 12**

Design Principles for Web Connectivity: Web Communication Protocols for Connected Devices, Message Communication Protocols for Connected Devices, Web Connectivity for Connected-Device a Network using Gateway, SOAP, REST, HTTP RESTful and Web Sockets **Internet Connectivity Principles**: Internet Connectivity, Internet-Based Communication, IP Addressing in the IoT, Media Access Control, Application Layer Protocols: HTTP, HTTPS, FTP, Telnet and Others.		
Unit – III:	**No. of Lectures: 09 hours**	**Marks: 12**
Data Acquiring, Organizing, Processing and Analytics: Data Acquiring and Storage, Organizing the Data, Transactions, Business Processes, Integration and Enterprise System, Analytics, Knowledge Acquiring, Managing and Storing Processes. **Data Collection, Storage and Computing Using Cloud Platform:** Cloud Computing Paradigm for Data Collection, Storage and Computing, everything as a Service and Cloud service Models, IoT Cloud-Based Services using the Xively, Nimbits and Other Platforms.		
Unit – IV:	**No. of Lectures: 09 hours**	**Marks: 12**
Sensors, Participatory Sensing, RCIDs, and Wireless Sensor networks: Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuator, Sensor Data Communication Protocols, Radio Frequency Identification Technology, Wireless Sensor Networks Technology. **Prototyping the Embedded Devices for IoT and M2M:** Embedded Computing Basics, Embedded Platforms for Prototyping, Things Always Connected to the Internet/Cloud.		
Unit – V:	**No. of Lectures: 08 hours**	**Marks: 12**
Prototyping and Designing the software for IoT Applications: Prototyping Embedded Device Software, Devices, Gateways, Internet and Web/Cloud Services Software-Development, Prototyping Online Component APIs and Web APIs. **IoT Privacy, Security and Vulnerabilities Solutions:** Vulnerabilities, Security Requirements and Threat Analysis, Use Cases and Misuse Cases, IoT Security Tomography and Layered Attacker Model, Identity Management and Establishment, Access Control and Secure Message Communication, Security Models, Profiles and Protocols for IoT.		
Text Books:		
1. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill.		
Reference Books:		
1. Jeeva Jose, “Internet of Things”, Khanna Publishing House, Delhi.		

ARTIFICIAL INTELLIGENCE					
COURSE					
Course Title:	**Artificial Intelligence**	**Short Title:**	**AI**	**Course Code:**	

Course description:

This course is to introduce the students to the fundamentals of Artificial Intelligence, Expert Systems and Neural Networks and enable them to apply these concepts for solving real world problems.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	3	14	42	3

Prerequisite course(s):

C language

Course objectives:

1. To understand the various characteristics of Intelligent agents
2. To learn the different search strategies in AI
3. To learn to represent knowledge in solving AI problems
4. To understand the different ways of designing software agents
5. To know about the various applications of AI.

Course outcomes:

After successful completion of this course the student will be able to:

1. Use appropriate search algorithms for any AI problem
2. Describe a problem using first order and predicate logic
3. Apply the apt agent strategy to solve a given problem
4. Design software agents to solve a problem
5. Design applications for NLP that use Artificial Intelligence.

COURSE			
Artificial Intelligence		**Semester:**	**VIII**
Teaching Scheme:		**Examination scheme:**	
Lectures:	**3 hours/week**	**End Semester Exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exam (ISE):	**40 marks**

Unit–I:	No. of Lectures: 08 Hours	Marks: 12

Introduction to Artificial Intelligence:

Definitions of AI, History, Turing test, AI Problem and Techniques: Problem as State Space Search, Problem characteristics, Production System: Water Jug problem, Heuristic Search Techniques: BFS, DFS, A*, AO*, Mean Ends Analysis

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Knowledge Engineering:

Knowledge Representation Issues, Knowledge Representation using Predicate Logic, Knowledge Representation using Rules, Weak and Strong Filler Structures for Knowledge: Semantic net, Frames, Script, Conceptual dependency.

Unit–III:	No. of Lectures:08 Hours	Marks:12

Game Playing and Planning:

Game Tree, Min-max Search with Additional Refinements, Overview of Planning and types Goal Stack Planning : Block World, STRIPS, Nonlinear, Hierarchical and Other, Planning

Unit–IV:	**No. of Lectures:09 Hours**	**Marks:12**
Understanding, NLP and Expert System: Understanding as a constraint Satisfaction: Waltz's algorithm, Constraint determination, Trihedral figures labeling, Natural Language Processing Steps, Learning Techniques, Introduction to Expert system, Architecture of Expert System, Expert System Shell Knowledge Acquisition in Expert System		
Unit–V:	**No. of Lectures:08 Hours**	**Marks:12**
Neural Network: Characteristics of Neural Networks: Features of Biological Neural Networks, Biological Neural Networks, Performance Comparison of Computer and Biological Neural Networks Historical Development of Neural Network, Artificial Neural Networks: Terminology Models of Neuron: McCulloch-Pitts Model, Perception, Adeline Topology, Basic Learning Laws Learning Methods: Supervised and unsupervised		
Text Books:		
1. Elaine Rich, Kevin Knight and Shivshankar Nair" Artificial Intelligence".3rd Edition TMH. 2. B. Yegnanarayana "Artificial Neural Networks "PHI2005		
Reference Books:		
1. S. Rajasekaran and G.A. Vijayalakshmi, "Neural Networks, Fuzzy Logic, and Genetic Algorithms" PHI 2. Timothy J Ross, "Fuzzy Logic with Engineering Application", TMH 3. Dan W. Patterson, "Introduction to artificial intelligence and expert system", PHI.		

REFRIGERATION & AIR CONDITIONING LAB

COURSE OUTLINE

Course Title:	Refrigeration & Air Conditioning Lab	Short Title:	RACL	Course Code:

Course Description:

In this laboratory, this course familiarizes under graduate students with the terminologies associated with refrigeration & air conditioning, basic principles of psychrometry and applied psychometrics, refrigerants; vapor compression refrigeration and multi-stage vapor compression systems, components of vapor compression systems and other types of cooling systems. The learner can use this knowledge and apply in various industries as required.

	Hours/week	No. of weeks	Total hours	Semester Credits
Practical	2	14	28	01

Pre-requisite Course(s): Mathematics, Computational Methods, Design, Vibration, SOM etc.

Course Objectives:

This course is intended to provide engineering students with an application of important concepts, principles of refrigeration and emphasis on those areas considered most relevant in a Refrigeration and Air-Conditioning context with practical applications in engineering and technology.

1. To impart knowledge of basic concepts in Refrigeration and implementation to various engineering fields.
2. To provide the knowledge and methodology necessary for solving problems in the field of Refrigeration and Air-Conditioning.
3. Learning the fundamental principles and different methods of refrigeration and air conditioning.
4. Study of various refrigeration cycles and evaluate performance using P-H Chart and refrigerant property tables.
5. Understand the basic air conditioning processes on psychometric charts, evaluate properties of air for its applications in comfort and industrial air conditioning.
6. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

Course Outcomes:

After successful completion of this lab course the student will be able to:

1. Comprehend the performance parameters of Vapour Compression Refrigeration system and domestic refrigerator.
2. Evaluate cycle performance and actual coefficient of performance (C.O.P.) of ICE Plant.
3. Analyze the performance parameters of Vapour Absorption refrigeration system.
4. Apply the knowledge of psychrometry to various psychrometric processes in Air-conditioning system.
5. Know different types of compressors, expansion and Safety used in Refrigeration and Air-Conditioning system, charging of refrigeration system.
6. Understand the measuring instruments and various tools used in Refrigeration and Air-Conditioning Systems.

COURSE CONTENT

Refrigeration & Air Conditioning Lab		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
		End Semester Exam (ESE): Oral	**25 marks**
Practical's:	**2 hours/week**	**Internal Continuous Assessment (ICA):**	**25 marks**

(Any 6 Practical) Consists of minimum Four Trial Practical.

1. Trial on Vapour Compression Refrigeration Test Rig.
2. Trial on Ice Plant Test Rig.
3. Trial on Domestic Refrigerator Test Rig.
4. Trial on Vapour Absorption Refrigeration System.
5. Trial on Air Conditioning Test Rig.
6. Trial on Heat-Pump Test Rig.
7. Study of Construction of Hermetically Sealed Compressor and Actual Viewing of a Cut Section model of the same (Reciprocating, Rotary and Car A/C Compressor).
8. Study of Evacuation and Charging of Refrigeration System.
9. Study of Measuring Instruments and Various Tools used in Refrigeration and Air-Conditioning Systems.
10. Study of Expansion Devices, Solenoid Valve and Safety Devices Used in Vapor Compression System.
11. Visit to Cold Storage/Ice Plant/ Central Air Conditioning System.
12. Case Study on Cold Storage Plant.
13. Study of Thermostat, Humidistat, dryer and Oil Separator.

Text Books:

1. Khurmi Gupta, "Refrigeration & Air- Conditioning", S Chand, New Delhi.
2. Manohar Prasad, "Refrigeration & air conditioning", New Age Publishers, New Delhi.
3. Arora, Domkundawar, "Refrigeration & air conditioning", Dhanpat rai and Sons, New Delhi.

Reference Books:

1. Arora C. P., "Refrigeration and air conditioning", TMH, New Delhi.
2. Ananthnarayanan, "Basics of Refrigeration", TMH, New Delhi.
3. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
4. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill,
5. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

Guidelines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.

Guidelines for ESE: (Oral)

ESE will be based on the laboratory assignments submitted by the students in the form of journal. Evaluation will be based on the understanding and quality of lab work.

FINITE ELEMENT ANALYSIS AND SIMULATION TECHNIQUE LAB				
COURSE OUTLINE				
Course Title:	**Finite Element Analysis & Simulation Technique**	**Short Title:**	**FEAST**	**Course Code:**

Course Description:

This course introduces undergraduate students to Finite Element Analysis and Simulation Technique. The background required includes a sound knowledge of Mathematics, Strength of materials and Machine Design. The course aims at imparting knowledge of Finite Element Analysis and Simulation Technique.

	Hours/week	No. of weeks	Total hours	Semester Credits
Lecture	**2**	**14**	**28**	**03**
Practical	**2**	**14**	**28**	

Pre-requisite Course(s): Mathematics, Computational Methods, Design, Vibration, SOM etc.

Course Outcomes:

After successfully completion of this course students will be able to:

1. understand the basic finite element formulation techniques.
2. derive equations in finite element methods for 1D problems.
3. derive equations in finite element methods for 2D problems.
4. derive equations in finite element methods for 3D problems.
5. understand the basic concept of Simulation and its techniques

COURSE CONTENT

Finite Element Analysis and Simulation Technique Lab		**Semester:**	**VIII**
Teaching Scheme:		**Examination Scheme:**	
Lectures:	**2 hours/week**	**End Semester Exam (ESE): Practical:**	**25 marks**
Practical's:	**2 hours/week**	**Internal Continuous Assessment (ICA):**	**25 marks**

Unit – I:	**No. of Lectures: 04 hours**	

Introduction to Finite Element Method

Introductory Concepts: Introduction to FEM, Discretization going from part to whole approach, Physical problem, mathematical models and finite element solution, FEA as a integral part of CAD, Steps used in Finite Element Method, FEM Software's - Pre-processing, processing and post processing. Advantages and disadvantages of FEM, Types of Finite Elements.

Unit – II:	**No. of Lectures: 07 hours**	

One Dimensional Analysis

Discretization of one-Dimensional element, matrix analysis method, Derivation of Shape functions, element stiffness matrices, global stiffness matrix, application of boundary, and force vectors.

Assembly of Matrices - solution of problems in one dimensional structural analysis, Stepped and Taper Bars, Torsion of circular shaft.

Unit – III:	**No. of Lectures: 07 hours**	

Two-Dimensional Analysis

Introduction. Finite element analysis for truss element. Natural coordinates and coordinates transformations, Derivation of shape functions for triangular element. Analysis of structural vibration. Finite element formation of beams.

Unit – IV:	**No. of Lectures: 06 hours**	
Two-Dimensional Vector Variable Problems		
Equations of elasticity – Plane stress, plane strain problems, Applications to free vibration problems of rod and beam. Lumped and consistent mass matrices, Jacobian matrix, stress analysis of CST element, eigen value Problems.		
Unit – V:	**No. of Lectures: 04 hours**	
Simulation Theory		
Simulation: Introduction, definition, steps used in simulation, advantage and limitations, techniques of simulation. **System models and studies:** - concepts of a system, system environment, stochastic activities, continuous and discrete systems, system modelling, types of models, principles used in modelling, types of system studies, comparison of simulation and analytical methods, analogue computers and methods, hybrid computer		
Outline of Content: This course contains: A. 1. Analysis of I-cantilever beam. 2. Analysing Flow in a System of Pipes. 3. Analysis of Trusses. 4. Modal Analysis of Spring-Mass System. 5. Modal Analysis of continuous System. 6. Thermal analysis of any component. 7. Stress strain analysis of any component. 8. Kinematic Analysis and simulation of slider crank Mechanism. B. Three assignments on syllabus **Note:** Lab file should contain any five experiments by using any analysis software.		
Text Books:		
1. CAD/CAM and Automation by R. B. Patil, Tech max publication. 2. J.N. Reddy, an Introduction to Nonlinear Finite Element Analysis, OUP. 3. C.S. Krishnamoorthy., Finite element analysis TMH 4. J.N. Reddy, Finite element methods, McGraw hill publication ltd.		
Reference Books: 1. Robert Cook, “Concept an application of Finite element analysis” 2. Klaus-Jurgen Bhate, “Finite element analysis”, PHI 3. C.S. Desai and J.F. Abel, “Introduction to finite element methods”, CBS 4. Tirupati R. Chandrupatla, “Finite element analysis” PHI. 5. Geoffery Gordon, “System simulation” 6. Narsingh Deo, “System simulation with digital computers” 7. Kenneth Lt. Huebner, “The FEM for Engineers”, Wiley India Pvt. Ltd. New Delhi		
Guidelines for ICA:		
Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignment.		

Guidelines for ESE: (Practical)
ESE will be based on experiments performed & submitted by the students in the form of journal. Evaluation will be based on the understanding and quality of lab work.

PROJECT					
LAB COURSE OUTLINE					
Course Title:	**Project**	**Short Title:**	**PROJ**	**Course Code:**	

Course description:

Project represents the culmination of study towards the Bachelor of Engineering degree. The project offers the opportunity to apply and extend material learned throughout the program. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	6	**14**	**84**	**3**

End Semester Exam (ESE) Pattern: **Oral (OR)**

Prerequisite course(s):

Course objectives:

1. To understand the basic concepts & broad principles of projects.
2. To understand the value of achieving perfection in project implementation & completion.
3. To apply the theoretical concepts to solve problems with teamwork and multidisciplinary approach.
4. To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Conduct an engineering project
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

LAB COURSE CONTENT

Project		**Semester:**	**VIII**
Teaching Scheme:		**Examination scheme:**	
Practical:	**6 hours/week**	**End semester exam (ESE): (OR)**	**50 marks**
		Internal Continuous Assessment (ICA):	**50 marks**

In continuation with Project (Stage – I) at Semester – VII, by the end of Semester – VIII, the students should complete implementation of ideas as formulated in Project (Stage – I). It may involve fabrication / coding, experimentation, data analysis within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability. It may also include testing, results and report writing. Each student group should submit complete project report at the end of Semester-VIII in the form of Hard bound. Assessment for the project shall also include presentation by the students.

Each student group is required to maintain separate log book for documenting various activities of the project.

Suggestive outline for the complete project report is as follows.

Abstract

Chapter 1. Introduction

- Background
- Motivation
- Problem Definition
- Scope
- Objective
- Organization of Report
- Summary

Chapter 2. Literature Review

Chapter 3. Design & development / Experimentation & observation / Survey & Data collection

Chapter 4. Testing, Analysis & Validation / Results & discussions / Data interpretation

Chapter 5. Conclusion & Future Work

Bibliography

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Appendix

Guide lines for ICA:

The Internal Continuous Assessment (ICA) for project shall be based on continuous evaluation of students' performance, active participation, knowledge / skill acquired throughout semester and presentation by the students. The assessment shall be done jointly by the guide and departmental committee. A three-member departmental committee including guide, appointed by Head of the department, shall be constituted for the assessment. The assessment for Project in Semester – VIII shall be as per the guidelines given in Table – B.

Table – B

		Assessment by Guide				Assessment by Departmental Committee			
Sr. No.	Name of the Student	Attendance / Participation	Implementation	Results	Report	Depth of Understanding	Presentation	Demonstration	Total
	Marks	5	5	5	5	10	10	10	50

Guidelines for ESE:

In End Semester Examination (ESE), the student may be asked for presentation / demonstration and questions on Project. Evaluation will be based on answers given by students in oral examination.