



Bharatiya Vidya Bhavan's
SARDAR PATEL COLLEGE OF ENGINEERING
(Government Aided Autonomous Institute under Mumbai University)
Andheri (W) Mumbai - 400058



COURSE CONTENTS

(Final Year B.Tech. in Mechanical Engineering)

Year: 2019-20

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PC-BTM711 Design of Machines and Mechanical Systems**Course pre-requisites: Machine Design****Course Objectives:**

The objectives of this course are

- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
- To apply the detailed design procedure of the different types of machine elements and select appropriate theory of failure.
- To develop integrated approach for design of mechanical systems.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To design and evaluate adequacy of standard/custom-built machine elements such as spur/helical/bevel/worm gears, rolling element/journal bearings, mechanical seals and brakes/clutches to fulfil desired specifications and satisfy failure criteria
2. To discuss design of hydraulic circuits for mechanical systems
3. To integrate knowledge of mechanical engineering to develop design of basic system such as EOT crane and Centrifugal pump
4. To demonstrate ability to design and evaluate a complex mechanical system to meet real-life needs with appropriate considerations such as economic, environmental, social, ethical, manufacturability, sustainability, health, safety, legal and cultural

Course content:

Module No.	Details	Hrs.
Module 01	Design of spur, helical, bevels and worm gears.	10
Module 02	Selection of rolling contact bearings based on constant /Variable Load and speed conditions (includes deep groove ball bearing and cylindrical roller bearing)	4
Module 03	Design of hydro dynamically lubricated bearings (Self-contained) Selection of Mechanical Seals	5
Module 04	Design of Brakes: Disk, shoe and drum type. Design of lever arm Design of clutches: Single and multi-plate with springs, pressure and friction plate selection	6
Module 05	Design of Hydraulic Circuits for mechanical systems such as for achieving different machine tool operations	5
Module 06	Design of EOT crane system: Snatch Block assembly, Rope drum assembly, Overhead travelling mechanism assembly.	6
Module 07	Introduction to centrifugal pump and positive displacement pump such as gear pump, vane pump, etc. Design of main components of centrifugal pump - Motor selection, Suction and delivery pipe, Impeller, Impeller shaft, Volute casing. (system design approach)	6

Term Work:

Term work shall comprise of

- 1) Exercises on the above topics in the form of design calculations with sketches and or drawings.
- 2) Examination (MCQ) based on topics mentioned in latest GATE syllabus
- 3) Design and detailed assembly drawing on A2 drawing sheets of Min. **two** design problem
- 4) Course project*

***Course Projects-** There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. The projects will be developed by teams of Two to Four students and will consist of design of any system having min. 5 to 6 components.

Text Books:

1. Bhandari, V. B. *Design of machine elements*. Tata McGraw-Hill Education, 2010.
2. Shigley, Joseph E., Charles R. Mischke, and Richard G. Budynas. *Mechanical engineering design*. McGraw-Hill, 2004.
3. Robert, L. Norton. "Machine Design An Integrated Approach." (2006).
4. **Recommended Data Books**
 - a. V. Bhandari, *Machine Design Data Book*, McGraw Hill Education (2017)
 - b. Mahadevan K., Reddy K.B. *Design Data Handbook for Mechanical Engineering in SI and Metric Units*, CBS (2013)
 - c. *PSG Design Data Book*, PSG College, Coimbatore (2012)

Reference Books:

1. Spottes, M.F., Terry E. S., and Lee E.H. *Design of machine elements*. Vol. 2. Pearson Education India, 2004.
2. Maitra, Gitin M. *Handbook of gear design*. Tata McGraw-Hill Education, 1994.
3. Deutschman, D., Michels, W.J. and Wilson, C.E., *Machine Design Theory and Practice*, Macmillan, 1992.
4. Juvinal, R.C., *Fundamentals of Machine Component Design*, John Wiley, 1994.
5. PATIL, SP. *Mechanical System Design*, JAICO students Ed., 2014.
6. Rudenko, Nikola Feodos'evich, and Nikolaï Feodos'evich Rudenko. *Materials handling equipment*. Peace Pubs., 1964.
7. Sahu G.K., *Pumps*, New Age International, 2000

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-BTM714 Industrial Engineering and Project Management**Course pre-requisites: PCC-BTM605****Course Objectives:**

1. To understand knowledge areas and tool – techniques for efficient Industrial Engineering & Project Management.
2. Understand the role of Industrial Engineering & Project Management in an organization.
3. Develop an insight as to how Industrial Engineering & Project Management tool/techniques are used strategically for the betterment of organization.
4. To understand how it helps in customer focus, innovation, quality management, speeding up the processes and improvement in productivity in an organization.
To understand the Life cycle and phases of project management.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe the basic concepts in Industrial Engineering & Project Management.
2. To describe the various tools and Techniques in Industrial Engineering & Project Management.
3. To apply the various concepts and Tools in Industrial Engineering & Project Management for Industrial cases
4. To investigate the factors for improving the process and Managing the Project successfully.

Course Content:

Module No	Details	Hrs
1	<u>Industrial Engineering:</u> 1.INTRODUCTION Introduction to industrial engineering, history and contribution to industrial engineering, industrial engineering approach, techniques of industrial engineering, objectives of industrial engineering, system approach and industrial engineering, definition and concept of productivity, productivity measures, factors influencing productivity, productivity improvement techniques.	04
2	2. WORK STUDY & ERGONOMICS Work Study: Definition and objectives, importance and advantages, work study procedure. Method Study: Definition and objectives, scope and steps involved in method study, job selection, recording techniques, critical examination, development and selection of improved method, motion economy principles, installation and maintenance of proposed method. Work Measurement: Definition and objectives, techniques of work measurement, steps involved in work measurement, types of elements, time study equipments, performance rating and allowances, computation of standard time, predetermined motion time standards(PMTS)	08
3	<i>Self-study mode</i> ERGONOMICS: Definition and objectives of human engineering, man	-

	machine systems and their aspects and relationship with productivity, human factors affected by environment, methods to improve work environment. Evaluation of cultural fit on mergers and acquisitions of business enterprises.	
4	ADVANCE CONCEPTS IN INDUSTRIAL ENGINEERING Need of computers in industrial engineering, development of integrated systems, sharing of data and information, advantages of integrated systems, principles of integrated system design, MRP-I, MRP-II, JIT, BPR, SCM, EPR, Lean manufacturing, Green Manufacturing, Agile manufacturing, etc.	04
5	(A) Project Management: Introduction to Project Management, the triple constraint, Stakeholders, Project Management Knowledge Area, tools and techniques, Role of a Project Manager, job description, Suggested Skills, Importance of people and leadership skills. Project Management to the Mechanical Engineering context, Organizational Structure, Project Life Cycle, Phases and Nature of Mechanical Engineering projects, Trends affecting Mechanical Engineering Project Management, Globalization, Outsourcing, and Virtual Teams.	08
6	Project Time Management, Defining and Sequencing Project Activities and Dependencies, Developing Schedule, Gantt Chart, Critical Path Method, Project Uncertainty – PERT, Critical Chain Method, Resource loading and Resource Leveling, Schedule Controlling.	08
7	Project Cost Management, Estimating Techniques, Earned Value Management, Project Quality Management, Planning Quality, Performing Quality Assurance, Quality Control – Tools and Techniques, Project Resource Management, Development of Human Resource Plan, Project Organizational Chart and Responsibility Assignment, Multi project Scheduling and Resource Allocation, Project Communication Management, Identifying Stakeholders, Planning Communication, Project Risk Management, Identifying Risks; Common Sources of Risk in Mechanical Engineering Projects, Qualitative Risk Analysis: Probability and Impact Matrix, Quantitative Risk Analysis: Decision Trees, Planning Risk Response, Project Procurement Management, Planning and conducting procurement	10

Term work

1. Assignments based on above modules
2. Seminar based on recent advances in the course
3. At least one Case study conducted at industry

Teaching Methods:

1. The course will use the following pedagogical tools:
2. Discussion on concepts and issues on Industrial Engineering and Project Management use of in an organization.
3. Case discussion covering a cross section of gaining strategic advantage by applying Industrial Engineering and Project Management tools and techniques.
4. Projects/ Assignments/ Quizzes/ Class participation etc.

Text books:

1. Wehrich, Heinz, and Harold Koontz. *Management: A global perspective*. Tata McGraw-Hill, 2005.
2. Niebel, Benjamin W. Freivalds, Andris Benjamin W. Niebel, and AndrisFreivalds. *Methods, standards, and work design*. 2003.
3. Mundel, Marvin Everett. *Improving productivity and effectiveness*. Englewood Cliffs, NJ: Prentice-Hall, 1983.
4. Chase, Richard B., and Nicholas J. Aquilano. *Production and operation management*. R d Irwin, 1973.
5. Barnes, Ralph M. "Motion and time study ." (1949).
6. Sham H.S., *Work Study and Ergonomics*, Dhanpatrai & Sons, 2000.
7. Meredith, Jack R., and Samuel J. Mantel Jr. *Project management: a managerial approach*. John Wiley & Sons, 2011.
8. Lewis, James P. *Project Planning, Scheduling & Control, 4E*. McGraw-Hill Pub. Co., 2005.

Reference book

1. Larson, Erik W., and Clifford F. Gray. "Project management: The managerial process." (2011).
2. I.L.O. *Introduction to Work Study*, I.L.O., 1986.
3. Meredith, Jack R., and Samuel J. Mantel Jr. *Project management: a managerial approach*. John Wiley & Sons, 2011.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PR-BTM798 Project Stage I

Course pre-requisites: Recommended – all courses till semester VI

Course Outcomes:

Upon successful completion of the course, the students should be able to

1. integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
2. use knowledge for formulation / fabrication of the desired project
3. analyze the available resources and to select most appropriate one
4. apply principles of ethics and standards, skill of presentation and communication techniques

Course content:

Sr.no.	Description	Hrs./week
1	Student shall study the topic of project work in terms of data collection, analysis, and inferencing. The student shall prepare an interim report and shall present a seminar on the work done at the end of semester.	2 (contact) + 6 (self- study)

VA-BTM791 Cloud Computing

Course pre-requisites: General knowledge of networking, sensing, databases, programming, and related technology.

Course Objectives:

1. To learn how to use Cloud Services
2. To implement Virtualization
3. To implement Task Scheduling algorithms
4. Apply Map-Reduce concept to applications.
5. To build Private Cloud.
6. Broadly educate to know the impact of engineering on legal and societal issues involved

Course Outcomes:

At the end of course student will be able to

1. Analyze the Cloud computing setup with it's vulnerabilities and applications using different architectures.
2. Design different workflows according to requirements and apply map reduce programming model.
3. Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.
4. Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds
5. Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application
6. Broadly educate to know the impact of engineering on legal and societal issues involved in addressing the security issues of cloud computing.

Course Content:

Module No	Details	Hrs.
Module 01	1.Cloud Computing Introduction to cloud computing , Key aspects of CC, Benefits of CC, Cloud system, Services offered by CC, Old IT infrastructure vs. cloud 7. Web 1.0 to 4.0, SAAS, PAAS and IAAS, Public, Private and Hybrid Cloud	04
Module 02	2.CRM Introduction Introduction to CRM, Purpose of CRM, Benefits of CRM, CRM metrics CRM technologies, Channels, Customer, Why towards CRM, Salesforce.com and other CR products	04
Module 03	3.Salesforce Introduction Introduction to salesforce, salesforce Terminologies, logging into Salesforce, Salesforce user creation , Salesforce navigation term – Home ge , Salesforce navigation term – Records, Salesforce navigation term – Sidebar , Salesforce.com and Force.com, Database.com,Sales Cloud Overview ,Service cloud Overview, Editions of Salesforce, Types of Salesforce sandbox , Salesforce development, Tabs, objects and Fields	04

Module 04	4.Warehouse App Create Warehouse App, Custom Objects, Custom fields, Create records, Field types (DT), Tabs, Relationships 1. Master-Detail 2. Lookup 3. Record Format Formulas & Validation 1. Formula 2. Roll Up Summary 3. Improve Validation Rule	04
Module 05	5.VisualForce UI Technologies, VF Page, VF Architected, Benefits of VF, VF Inline Editor, MVC Introduction, MVC- Opportunities Tab, VF Key Elements, VF controllers, VF Types Controllers, Expression & Data Binding Versioning, VF Namespaces, Standard vs. Custom, VF Page compare to controls, Global Variables, VF Page get requests, VF Page post back requests	04
Module 06	6.Programmatic Logic with Apex Ways to develop Apps, Install Force.com IDE, Explain Force.com IDE, List variable, Iterate list, Apex trigger, Testing, Adding tests to App, Create Apex Test Class, Adding test Methods, Execute the test, Looking statements	04
Module 07	7.Other Understandings Rename standard Tabs, Data Format in SF, How Date DT works, How currency DT works, How Picklist DT works, Picklist & Multiselect DT, Change User Language, IE configuration	04

Term Work:

- It consists of **at least one** tutorial and/or assignments and/or hands-on exercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to Cloud Computing
- Mini Project

TEXT BOOKS:

1. The Enterprise Cloud: Best Practices for Transforming Legacy IT, by James Bond

REFERENCE BOOKS:

1. Cloud Computing: Concepts, Technology & Architecture, by Richardo Puttini, Thomas Erl, and Zaigham Mahmood

Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of Cloud Computing learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PR-BTM898 Project Stage II

Course pre-requisites: Recommended – all courses till semester VI

Course Outcomes:

1. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
2. Student will be able to use knowledge for formulation / fabrication of the desired project
3. Student will be able to analyze the available resources and to select most appropriate one
4. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques

Course content:

Sr.no.	Description	Hrs./week
1	Student shall study the topic of project work and define problem statement. The student shall evolve design and/or do experimental study and/or fabricate engineered device to obtain solution to the identified problem. The student shall prepare a report and shall present a seminar on the basis of work done at the end of semester.	2 (contact) + 12 (self- study)

VA-BTM891 Big Data Analytics

Course pre-requisites: General knowledge of networking, sensing, databases, programming, and related technology.

Course Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Course Outcomes:

1. **Understand** the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. **Acquire** fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. **Interpret** business models and scientific computing paradigms, and apply software tools for big data analytics.
4. **Achieve** adequate perspectives of big data analytics in various applications like recommender systems, social media applications

Course Content:

Module No	Details	Hrs.
Module 01	1. Overview of Big Data History of big data, its elements, career related knowledge, advantages, disadvantages	04
Module 02	2. Technologies for Handling Big Data Introduction to Hadoop, functioning of Hadoop, Cloud computing (features, advantages, applications) etc	04
Module 03	3. Understanding Hadoop Ecosystem Hadoop and its ecosystem which includes HDFS, MapReduce, YARN, HBase, Hive, Pig, Sqoop, Zookeeper, Flume, Oozie etc. Dig Deep to understand the fundamental of MapReduce and HBase framework of MapReduce and uses of mapreduce.	04
Module 04	4. Understanding Big Data Technology Foundations big data stack i.e. data source layer, ingestion layer, source layer, security layer, visualization layer, visualization approaches etc. Databases and Data Warehouses Databases, polygot persistence and their related introductory knowledge	04
Module 05	5. Using Hadoop to store data HDFS, HBase and their respective ways to store and manage data along with their commands. Learn to Process Data using Map Reduce. This emphasizes on developing simple mapreduce framework and the concepts applied to it.	04

Module 06	6.Hadoop YARN Architechure Background of YARN advantages of YARN, working with YARN, backward compatibility with YARN, YARN Commands, log management etc. Testing and Debugging Map Reduce Applications	04
Module 07	7.Learn NoSQL Data Management NoSQL including document databases, relationships, graph databases, schema less databases, CAP Theorem etc. Exploring Hive, Exploring Pig, Exploring Oozie, Integrating R and Hadoop and Understanding Hive in Detail	04

Term Work:

- It consists of **at least one** tutorial and/or assignments and/or hands-on excercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to Big data analytics
- Mini Project

TEXT BOOKS:

1. Data Analytics : The Complete Beginner's Guide - Step By Step Instructions (The Black Book) Kindle Edition, by [Byron Francis](#)

REFERENCE BOOKS:

1. Big Data and Analytics 1st Edition, Kindle Edition, by [Subhashini Chellappan Seema Acharya](#)

Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of Big Data Analytics learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM711 Process Equipment Design and Piping Engineering
Course pre-requisites: Machine Design

Course Objectives:

The objective of this course is to:

- Learn reading and interpretation of essential design documents such as P&ID and equipment data sheets.
- Prepare student to obtain sizes of important process equipment and piping components subjected to different types of loading.
- Make students able to handle stress/thermal analysis of pressure and piping components using advanced methods such as finite element method.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Explain and interpret essential design documents such as PFD, P&ID, Data Sheets and Technical Specifications.
2. Calculate size of major process equipment and piping components using theoretical formulae, rules of international design codes/standards as well as IT tools.
3. Design of pressure vessels, heat exchangers and piping as part of engineering system of process plant.
4. Explain and apply the knowledge of piping engineering such as reading pipe layout, compatibility of materials for service and fabrication, selection of fittings and supports, and features of different international codes associated to piping engineering.

Course contents:

Sr. No.	Description	Duration (hrs.)
1	Introduction: Role of process equipment/ piping engineer in industry, organization and working of EPC company, Interpretation of process diagrams such as P&ID, Design codes and standards such as ASME BPVC, ASME B31.1/31.3, IBR, IS2825.	4
2	Materials of Construction and Fabrication Material classification and selection of material for various industrial processes, Preparation of Material Specification Sheets. Review of fabrication, inspection and testing methods.	4
3	Design of pressure components such as shell, head, cone for internal pressure loading. Design of cylindrical shells against external pressure; design of stiffener rings.	8
4	Advanced design topics such as nozzle reinforcement calculation, bolted flange design, selection of gaskets. Elementary stress analysis of pressure parts using finite element methods.	8
5	Design of supports for tall vertical vessels; skirt support subjected to wind	6

	and seismic loads. Elementary heat exchanger design. Tubesheet thickness calculations, baffle plate design	
6	Design of Pipes and Pipe Fittings Pipe specification, Calculations for pipeline sizing, Pressure drop in pipelines, Design and selection of piping components such as straight pipe and bends.	6
7	Pipe Supports Study and selection of various types of pipe supports. Design considerations, supporting span of overhead pipelines. Piping Flexibility Introduction to piping flexibility analysis.	6

Term Work:

1. Assignments based on each module
2. Mini project based on design by analysis for a pressure component and piping flexibility analysis.

Recommended Books:

1. Brownell, Lloyd E., and Edwin H. Young. *Process equipment design: vessel design*. John Wiley & Sons, 1959.
2. Harvey, John F., and H. Saunders. "Theory and design of pressure vessels.", Van Nostrand Reinhold Company, 1987.
3. MW Kellogg Co. *Design of Piping Systems*. Wiley, 1961.

Reference Books:

1. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and 2, ASME, 2017.
2. ASME B31.3 Process Piping, ASME, 2016.
3. Mahajan, Kanti K. "Design of process equipment: selected topics.", Pressure Vessel Handbook Pub, 1992.

Term work:

- Assignment based on each module.
- Report of visit to a process industry plant.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM712 Design For Manufacturing and Assembly**Course pre-requisites: Machine Design****Course Objectives:**

1. To develop an ability to create product designs which are suitable and economical to manufacture and assemble.

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

1. discuss the product development cycle
2. identify the manufacturing issues that must be considered in the mechanical engineering design process
3. apply principles of assembly to minimize the assembly time
4. explain the effect of manufacturing process and assembly operations on the cost of product.

Course Contents:

Sr. No.	Syllabus	Hrs
1.	Introduction Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Selection of Materials and Shapes.	6
2.	Properties of Engineering Materials, Selection of Materials – I, Selection of Materials – II, Case Studies – I, Selection of Shapes, Co-selection of Materials and Shapes, Case Studies – II,	6
3.	Selection of Manufacturing Processes, Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Co-selection of Materials and Processes, Case-Studies – III	8
4.	Design for Assembly, Review of Assembly Processes, Design for Welding – I, Design for Welding – II, Design for Brazing and Soldering,	6
5.	Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies - IV	6
6.	Design for Reliability, Failure Mode and Effect Analysis and Quality, Design for Quality,	5
7.	Design for Reliability, Approach to Robust Design, Design for Optimization	5

Term Work:

1. Assignments based on each module
2. Mini project based on course content.

Reference Books:

1. M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 03.
2. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 00.
3. M F Ashby, Material Selection in Mechanical Design, Butterworth-Heinemann, 1999.
4. T H Courtney, Mechanical Behavior of Materials, McGraw Hill, NY, 00.
5. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold,1997.
6. S S Rao, Engineering Optimization: theory and practice, John Wiley, NY, 1996.
7. G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.
8. J G Bralla, Handbook for Product Design for Manufacture, McGraw Hill, NY, 1998.
9. Houldcroft, Which Process – an introduction to welding and related processes and guide to their selection, Cambridge, Abington Pub., 1990.
10. ASTM Design handbook.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

PE-BTM713 Introduction to Design of Power Transmission**Course pre-requisites: Machine Design****Course Objectives:**

1. After learning this Course the student will understand the Detail Design Procedure of the Transmission Systems – Mechanical, Hydraulic, Pneumatic general description and comparison
2. The student will learn Components like couplings, belts, chains, gears, brakes, clutches, shafts, bearing, housing pumps, valves in detail and will be in position to design and select them suitably.
3. The student will also learn some Case studies of Design of Power Transmission System [mechanical and hydraulic systems] to reinforce their concepts.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Select and design various mechanical and hydraulic power transmission system.
2. Analyze vibration characteristics, wear and life of critical components of power transmission systems.
3. Calculate sizing of elements of transmission systems like couplings, belts, chains, gears, brakes, clutches, shafts, bearing, housing pumps, valves in detail.
4. Discuss case studies on power transmission system design.

Course contents:

Sr. No.	Course Details	Hrs
1	Different types of prime movers, characteristics, limitation application and selection	2
2	Transmission Systems – Mechanical, Hydraulic, Pneumatic general description and comparison Components like couplings, belts, chains, gears, etc used. Their limitations and use in specific applications. Typical example of mechanical and hydraulic systems.	8
3	Components like brakes, clutches, shafts, bearing, housing pumps, valves etc used. Their limitations and use in specific applications. Typical example of mechanical and hydraulic systems.	12
4	Analysis for applications (automobile m/c Tool, Process engineering) and data for design- Selection of components, Standard components use and selection.	4
5	Synthesis of above elements of system and get complete solution.	4
6	Analysis of the solution further with respect to vibration, wear, life of critical components, reliability, assembly, maintenance and cost.	4
7	Case studies on Power Transmission System Design	8

Term Work

- Assignments based on above modules
- Seminar based on recent advances in the subject
- At least one Case study conducted at industry

Text and Reference books

1. Vicker's Industrial Hydraulics Manual, Eaton Hydraulics Training, 5th Edition, 1999.
2. Rohner, Peter. *Industrial hydraulic control: a textbook for fluid power technicians*. Prentice Hall, 1987.
3. Pippenger, John J. Hicks, Tyler G. John J. Pippenger, and Tyler G. Hicks. *Industrial hydraulics*. 1979.
4. Fundamentals of Pneumatics – Festo didactic GmbH & Co., 2000.
5. Esposito, Anthony. *Fluid power with applications*. Prentice-Hall International, 2000.
6. Bhandari, V.B, *Design of Machine Elements*, Tata McGraw Hill Education Pvt Ltd.
7. Shigley, J.E and C R Mischke, *Mechanical engineering Design*, McGraw Hill Inc.
8. Spotts, M F and T E Shoup, *Design of Machine Elements*, Prentice Hall Inc.
9. Spotts, M F, *Mechanical Design Analysis*, Prentice Hall Inc.
10. John J .Pippenger and Dudley A. Peace, *Basic Fluid Power*, Prentice Hall Inc.
11. Fundamentals of Pneumatics, *Electro-Pneumatics and Electro-Hydraulics*, FESTO Didactic, 2000
12. Michael J. Pinches and John G. Ashby, *Power Hydraulics*, Prentice Hall Inc

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

PE-BTM714 Electric Vehicle Design and Development**Course pre-requisites: Engineering Sciences****Course Objectives:**

- Student must be familiar with this course to know commercial considerations, such as economics, marketing, and sales.
- Students must be familiar with operation of electric motor AC and DC, torque speed characteristics. motor control electronics, ac dc conversion
- This syllabus covers electric vehicle powertrain, motor control system, battery management system, electric vehicle control unit and electric vehicle chargers.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To explain analytical design of the complete motor vehicle, Vehicle Body Engineering and current motor vehicle design.
2. To evaluate the vehicle performance and different losses or resistances occur during driving the vehicle
3. To explain concepts and theory of electric powertrain of the vehicle
4. To explain different types of chargers, their structure and usage.

Course contents:

Sr. No.	Details	Hrs.
Module 01	Introduction: Brief history of electric vehicles and comparative evolution with respect to petroleum vehicles. High level block diagram: Main parts of electric vehicles. Motor, controller, battery, battery management system, electric vehicle control unit. Vehicle performance: Tractive force, Tractive force Vs Vehicle speed, resistance to motion of the Vehicle – Rolling and gradient resistance, power requirement for acceleration and gradeability, maximum acceleration for front wheel drive – Rear wheel drive – four wheel drive Vehicles.	02
Module 02	Transmission Systems: Study of Propeller shaft and universal joint, live axle and differential Steering and front axles: Steering geometry, Steering requirements, Steering linkages and Steering gears, over Steer and under Steer, cornering power, reversibility of Steering gears, types of front axles their constructions, troubleshooting and remedies	02
Module 03	Wheels and tyres: requirements of Wheels and tyres, constructional features, types of tyres, application to ride and stability, troubleshooting and remedies. Lighting system: types of lamps, Energy demands of lighting system, construction and types of head lamps. Different accessories used in vehicles: Electric Horn, Wipers, power operated windows, etc.	02

Module 04	<p>Vehicle Body Design: importance of body design, material for body constructions – styling forms – coach and bus body style, layouts of passenger cars, bus and Truck bodies. Aerodynamic drag – aerodynamic lifts, pitching moments, side force, yawing moments and Rolling moments.</p> <p>Chassis types and structure types: open semi integral pedal and integral Bus structures.</p> <p>Frames: function and types, loads on frames, load distribution of structure.</p>	02
Module 05	<p>Vehicle vibration and dynamics: types of vibration, vibration control, effect of vibration on human body, Driver's comfort and passenger comfort vehicle vibration with single degree of vibration.</p> <p>Suspension systems: objects of Suspension, basic requirements, types of Suspension, shock absorbers</p>	02
Module 06	<p>Battery Management System: Importance of battery management system, battery management system design, onboard chargers, cell balancing, battery life optimization, battery cooling systems</p> <p>Electric Vehicle Charging: AC DC Charging, Charger protocols, Charging standards and interfaces (Type2, Chademo), Charging method effect on battery, charging characteristics of battery</p>	02
Module 07	<p>Electric Vehicle Control Unit: principal of operations, interfacing with many sensors. design protocols, power management calculations, design considerations (vehicle use cases), safety optimization, performance optimization</p>	02

Term Work:

Assignments and laboratory experiments of

1. Study of motor control system.
2. Study of battery management system.
3. Study of suspension system.
4. Study of basic dimension and vehicle layout.
5. Study of electric vehicle control unit.
6. Study of wheels and tyres.
7. Study of electric vehicle chargers.
8. Study of different drives.
9. Study of steering system.

Text Books / Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM715 Introduction to Fracture Mechanics**Course pre-requisites: Solid Mechanics****Course Objectives:**

1. To expand student's knowledge in the area of linear-elastic fracture mechanics and the stress analysis of cracked bodies with a focus on metallic structures.
2. To develop student's ability to compute crack-tip stress-intensity factors for two and three-dimensional cracked bodies of LEFM.
3. To develop student understands of the relationship between the energetic approach and the stress analysis of cracked bodies.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Analyze nature of stresses around a cracked body by applying principles of linear elastic fracture mechanics and compute stress intensity factors.
2. Interpret the result of a fracture mechanics analysis for metallic structures and relate the same to ASME/API.
3. Explain experimental methods for K_{Ic}/J - testing using various types of test specimens.
4. Evaluate the fracture related failures.

Course contents:

Sr. No.	Description	Hrs.
1	Introduction- background, Kinds of failure, modes of failure, brittle and ductile fracture.	4
2	Energy Consideration- Introduction, Griffith analysis, energy release rate.	8
3	Stress in cracked bodies- Stress intensity factor, determination of SIF, CTOD.	8
4	J integral- Definition, scope, path independence.	8
5	Test methods- introduction, K_{Ic} test technique, J testing, various test specimens.	4
6	Fatigue- introduction, terminology, S-N curve, fractures due to fatigue, Paris law for design of components.	6
7	Fracture mechanics indesign process, Practical Case studies.	4

Term Work:

- Assignments based on each module
- Mini project based on course content

Recommended Books:

1. Kumar, Prashant, and Kumar Prashant. *Elements of fracture mechanics*. Tata McGraw-Hill Education, 2009.

2. Anderson, Ted L. *Fracture mechanics: fundamentals and applications*. CRC press, 2005.
3. Maiti, S. K. *Fracture Mechanics: Fundamentals and Applications*. Cambridge University Press, 2015.
4. Kanninen, Melvin F., and Carl L. Popelar. "Advanced fracture mechanics." (1985).
5. Barson, J. M., and Stanley T. Rolfe. "Fracture and Fatigue Control in Structures: applications of fracture mechanics." *American Society for Testing and Materials, West Conshohocken, PA* (1999): 194.
6. Gdoutos, Emmanuel. *Fracture mechanics criteria and applications*. Vol. 10. Springer Science & Business Media, 2012.
7. KRY Simha
8. Handbook by Tada,Sih&Paris
9. Use of visual videos for the course.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

PE-BTM716 Design of Material Handling Equipment**Course pre-requisites: Machine Design****Course Objectives:**

On successful completion of the course, students should be able to

- Understand the basics of material handling equipment like elevators, conveyors and EOT cranes.
- Design the main components of the belt conveyor system.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. create mechanical design of material handling systems by integrating knowledge of mechanical engineering courses
2. compare and evaluate available design alternatives and to select the most suitable one to fulfil technical requirements of the system
3. discuss and review the design features and requirements of different material handling systems
4. demonstrate ability to design and evaluate a material handling system to meet real-life needs with appropriate considerations such as economic, environmental, social, ethical, manufacturability, sustainability, health, safety, legal and cultural through completion of course design project

Course content:

Sr. No.	Description	Duration (hrs.)
1	Introduction to material handling equipment, i.e. hoists, cranes, elevators, conveyors etc.	7
2	Basic problems of material handling and principles of material handling system design and selection of system components	7
3	Design of EOT crane for: Snatch Block assembly, Rope drum assembly, Overhead travelling mechanism assembly.	7
4	Rotary cranes, design considerations for structures of rotary cranes with fixed radius; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes	7
5	Design of belt conveyors-- Power requirement, selection of belt, design of tension take up unit, idler pulley etc.	7
6	Design of screw conveyor	7
7	Design of packages, protective packaging, testing the physical characteristics of packaging, container testing, types of storage and industrial containers, Automatic guided vehicles, Automatic storage and retrieval system	7

Term Work:

The term work shall consist of

1. Design project: The design project shall consist of two imperial size sheets - one involving assembly drawing with a part list and overall dimensions and the other involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances.

A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file.

2. Assignments based on above topics.

Text Books:

1. Conveyor Equipment Manufacturer's Association, "Belt conveyors for bulk materials", 6th edition, The New CEMA Book
2. Rudenko N., "Materials handling equipment", Elnvee Publishers, 1970
3. Ishwar G Mulani and Mrs. Madhu I Mulani, "Engineering Science and application design for belt conveyor", Madhu I. Mulani, 2002.
4. **Recommended Data Books**
 - a. V. Bhandari, *Machine Design Data Book*, McGraw Hill Education (2017)
 - b. Mahadevan K., Reddy K.B. *Design Data Handbook for Mechanical Engineering in SI and Metric Units*, CBS (2013)
 - c. *PSG Design Data Book*, PSG College, Coimbatore (2012)

Reference Books:

1. Spivakovsy A.O. and Dyachkov V.K., "Conveying Machines, Volumes I and II", MIR Publishers, 1985.
2. Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 1981.
3. Boltzharol, A., "Materials Handling Handbook", The Ronald press company 1958.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM717 Compliant Mechanisms**Course pre-requisites: Kinematics of Machinery****Course Objectives:**

1. To develop the student's understanding on variants of compliant mechanisms
2. To develop the student's understanding on working of compliant mechanisms
3. To develop student's understanding on analysis of compliant mechanisms.

Course Outcomes:

Upon successful completion of the course, students should be able to..

1. Explain working of complaint mechanisms
2. Distinguish the difference between conventional and compliant mechanisms
3. Analyse compliant mechanisms for displacement
4. Design basic compliant XY scanning mechanisms

Course Contents:

Sr. No.	Description	Hrs.
1	Introduction - Definition of compliant mechanisms - Advantages and disadvantages of compliant mechanisms Nomenclature and Diagrams	4
2	Flexibility and Deflection - Linear vs. nonlinear deflections - Stiffness, strength, and flexibility - Materials choice - Linear elastic deflections - Large-deflection analysis	6
3	Analysis of Flexure Mechanisms in the Intermediate Displacement Range Modeling Geometric Nonlinearities in Beam Flexures Beam Constraint Model Case Study: Parallelogram Flexure Mechanism	6
4	Modeling of Large Deflection Members Equations of Bending for Large Deflections Solving the Nonlinear Equations of Bending Examples-- Fixed-Pinned Beam, Fixed-Guided Beam (Bistable Mechanism)	6
5	Pseudo-Rigid-Body Model - Introduction - Pseudo-rigid-body models for flexible segments - Pseudo-Rigid-Body Models for Planar Beams Modelling of Mechanisms	6
6	Compliant Mechanism Synthesis - Rigid-body replacement	6

	<ul style="list-style-type: none"> - Synthesis through Freedom and Constraint Topologies - Synthesis through Topology Optimization 	
7	Case Studies: <ol style="list-style-type: none"> 1. Compliant mechanism in microsterolithography 2. Spiral Shaped flexural bearing for compressor of cryocooler 3. Flexural based mechanisms in machine tools 	8

Tutorial

1. Assignments on each module
2. Case studies on applications of Compliant Mechanisms
3. Seminar on recent advances in Compliant Mechanisms
4. Demonstration of compliant mechanisms through Origami models

Recommended References:

1. Handbook of Compliant Mechanisms by Larry L. Howell and Brian M. Olsen, John Wiley & Sons.
2. Compliant Mechanisms by Nicolae Lobontiu, CRC press
3. Compliant Mechanisms by Larry L. Howell, John Wiley & Sons, Inc. ISBN 0-471-38478-X
4. Thesis “Synthesis and analysis of parallel Kinematic XY flexure mechanisms” by Shorya Awatar, Doctoral Research at MIT.
5. Flexures: Elements of Elastic Mechanisms, S. T. Smith, CRC press

Sr. No.	Examination	Module
1.	T-I	1,2
2.	T-II	3,4
3.	End Sem	1 to 7

PE-BTM731 Business Process Reengineering and Total Quality Management**Course pre-requisites: Manufacturing Planning and Control****Course Objectives**

The objectives of the course are to

- Understand the role of Business Process Reengineering technique in an organization.
- Develop an insight as to how BPR tool/techniques are used strategically for the betterment of organization
- To understand how it helps in customer focus, innovation, quality management, speeding up the processes and improvement in productivity in an organization.
- To understand the Total Quality Management concept and principles and the various tools available to achieve Total Quality Management.
- To understand the statistical approach for quality control.
- To create an awareness about the ISO and QS certification process and its need for the industries.

Course Outcomes

Upon successful completion of the course, students should be able

1. To understand the various concepts, philosophies, principles in BPR and TQM
2. To understand and apply various tools and techniques used in BPR and TQM
3. To apply statistical quality control tools for process improvements
4. To investigate the factors affecting Successful implementation of BPR and TQM in given cases

Course content:

Module No	Details	Hrs
1	BPR: Introduction to BPR, Concept, Need for Reengineering, Benefits, guiding principles, BPR and performance Improvement, Pitfalls in BPR, Myths of BPR.	6
2	BPR implementation methodology, Success factors of BPR, Barriers to BPR	4
3	BPR in Manufacturing industry, BPR and IT, BPR and relevant technologies, BPR and ERP	6
4	TQM: Definition of quality, Dimensions of quality, Quality costs, Basic concepts of total quality management, Principles of TQM, Quality statements, Deming Philosophy, Juran trilogy, Crosby's Philosophy, PDCA cycle	6
5	5S, Kaizen, Benchmarking, Benchmarking process, Quality Function Deployment (QFD), House of quality, Taguchi quality loss function, Total Productive Maintenance (TPM), FMEA, Stages of FMEA	6
6	The seven tools of quality, Statistical fundamentals, Measures of central tendency and dispersion, Population and sample, Normal curve, Control charts for variables and attributes, Process capability, Concept of six sigma.	8
7	Need for ISO 9000 and other quality systems, ISO 9000:2000 quality system, Elements, Implementation of quality system, Documentation, Quality auditing, TS 16949, ISO 14000, Concept, Requirements and Benefits	6

Teaching Methods:

The course will use the following pedagogical tools:

- A Discussion on concepts and issues on BPR use of in an organization.
- B Case discussion covering a cross section of gaining strategic advantage by applying BPR tools and techniques.
- C Projects/ Assignments/ Quizzes/ Class participation etc.

Term work: Assignments containing problems based on each module.

Seminar based on recent advances in subject.

Text book:

1. Radhakrishnan, R., and S. Balasubramanian. *Business Process Reengineering: Text and Cases*. PHI Learning Pvt. Ltd., 2008.
2. Dey, B. R. *Business Process Reengineering & Change Management*. John Wiley & Sons, 2004.
3. Besterfield, Dale H. "Total Quality Management. 2003."
4. Jain, Jain PL. *Quality Control and Total Quality Management*. Tata McGraw-Hill Education, 2001.

Reference book:

1. Khoong, Chan Meng, Henry J. Johansson, Patrick McHugh, A. John Pendlebury, and William A. Wheeler. "Business Process Reengineering: Breakpoint Strategies for Market Dominance." (1997): 112-114.
2. Grover, Varun, and William J. Kettinger, eds. *Business process change: Concepts, methods, and technologies*. IGI Global, 1995.
3. Feigenbaum, A. V. A. V. *Total quality control*. 1983.
4. Narayana, V., and N. S. Sreenivasan. "Quality Management–Concepts and Tasks." *New Age International* 3 (1996).
5. Bounds, Gregory M. *Beyond total quality management: Toward the emerging paradigm*. McGraw-Hill College, 1994

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM732 Customer Relationship Management (CRM)**Course pre-requisites: Elements of Industrial Management****Course Objectives:**

The objectives of the course are

1. To describe concepts and principles of CRM
2. To consider role of IT function in CRM
3. To facilitate understanding of Customer Relationship

Course Outcomes:

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

1. Explore consumer behavior and consumer preferences for FMCG and other industries
2. Development of strategy for loyal customer
3. Explore factors affecting customer relationship management
4. Identify role of IT for enhancing effectiveness of CRM

Course content:

Module No	Details	Hrs
1	CRM concepts - Acquiring customers, - Customer loyalty and optimizing customer relationships - CRM defined - success factors, the three levels of Service/ Sales Profiling	6
2	CRM in Marketing - One-to-one Relationship Marketing - Cross Selling & Up Selling - Customer Retention, Behaviour Prediction - Customer Profitability & Value Modeling, - Channel Optimization - Event-based marketing. - CRM and Customer Service - Customer Satisfaction Measurement.	8
3	Sales Force Automation - Sales Process, Activity, Contact- Lead and Knowledge Management - Field Force Automation.	4
4	CRM links in e-Business - E-Commerce and Customer Relationships on the Internet - Enterprise Resource Planning (ERP), - Supply Chain Management (SCM), - Supplier Relationship Management (SRM), - Partner relationship Management (PRM)	6
5	Analytical CRM - Managing and sharing customer data - Customer information databases - Ethics and legalities of data use - Data Warehousing and Data Mining concepts - Data analysis	6
6	CRM Implementation - Defining success factors - Preparing a business plan requirements, justification and processes. - Choosing CRM tools - Defining functionalities - Homegrown versus out-sourced approaches	6
7	Managing customer relationships - conflict, complacency, Resetting the CRM strategy. Selling CRM internally - CRM development Team - Scoping and prioritizing - Development and delivery - Measurement	6

Term work:

- Assignments containing problems based on each module.
- Seminar based on recent advances in subject.
- Case studies

Text/Reference books:

1. Alok Kumar Rai, CUSTOMER RELATIONSHIP MANAGEMENT CONCEPT & CASES, Prentice Hall of India Private Limited, New Delhi. 2011
2. S. Shanmugasundaram, CUSTOMER RELATIONSHIP MANAGEMENT, Prentice Hall of India Private Limited, New Delhi, 2008
3. Kaushik Mukherjee, CUSTOMER RELATIONSHIP MANAGEMENT, Prentice Hall of India Private Limited, New Delhi, 2008
4. Jagdish Seth, et al, CUSTOMER RELATIONSHIP MANAGEMENT
5. V. Kumar & Werner J., CUSTOMER RELATIONSHIP MANAGEMENT, Willey India, 2008

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM733 Industrial Robotics**Course pre-requisites: Kinematics and Dynamics of Machines, Mechatronics****Course Objectives:**

On successful completion of course, students should be able to

1. Understand the anatomy of different ROBOTS
2. Know programming of ROBOTS
3. Develop the ROBOTS in concern with society

Course Outcome:

Upon successful completion of the course, students should be able

1. To describe the basic anatomy of ROBOT
2. To explain programming in ROBOTICS
3. To apply knowledge for development of ROBOT
4. To decide social issues & economics of robotic

Course content:

Sr. No.	Details	Hrs.
Module 01	1.1 INTRODUCTION: Automation & robotics, Robotic System & Anatomy Classification, Future Prospects 1.2 DRIVES: Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators, Power Transmission Systems. 1.3 ROBOT & ITS PERIPHERALS: End Effecters - types, Mechanical & other grippers, Tool as end effector 1.4 SENSORS: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Uses Vision Systems - Equipment	6
Module 02	2 MACHINE VISION: Introduction, Low level & High level vision, Sensing & Digitising, Image processing & analysis, Segmentation, Edge detection, Object description & recognition, Interpretation, Applications	6
Module 03	3 PROGRAMMING FOR ROBOTS: Methods, Robot programme as a path in space, Motion interpolation, level & task level languages, Robot languages; Programming in suitable languages Characteristics of robot.	6
Module 04	4 ROBOT KINEMATICS: Forward, Reverse & Homogeneous Transformations, Manipulator Path Control, Robot Dynamics.	6
Module 05	ROOT INTELLIGENCE & TASK PLANNING: Introduction, State space search, Problem reduction, Use of predictive logic, Means -Ends Analysis, Problem solving, Robot learning, Robot task planning.	6
Module 06	ROBOTIC APPLICATION IN MANUFACTURING: Material transfer, Machine loading & unloading, Processing operations, Assembly & Inspectors, Robotic Cell Design & Control.	6
Module 07	SOCIAL ISSUES & ECONOMICS OF ROBOTICS	6

Term Work:

Term work shall consist of minimum **06** assignments at least one on each module, programming of robots

Text Books

1. Ramamurti, Viswanatha. *Computer aided design in mechanical engineering*. New Delhi: Tata McGraw-Hill, 1987.
2. Paul, Richard P. *Robot manipulators: mathematics, programming, and control: the computer control of robot manipulators*. Richard Paul, 1981.
3. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. *Industrial Robotics: Technology, Programming and Application*. McGraw-Hill Higher Education, 1986.
4. N-Nagy, Francis L. "Robotic engineering: An integrated approach: Richard D. Klafter, Thomas A. Chmielewski and Michael Negin Prentice-Hall International, 1989.

Reference Books:

1. Koren, Yoram, and YoramKoren. *Robotics for engineers*. Vol. 168. New York et al: McGraw-Hill, 1985.
2. Engelberger, Joseph F. *Robotics in practice: management and applications of industrial robots*. Springer Science & Business Media, 2012.
3. Grover, D. J. "Computer integrated manufacturing technology and systems: Ulrich Rembold, Christian Blume and Ruediger Dillmann, Marcel Dekker Inc, Cimarron Road, Monticello, NY 12701, USA (1985)
4. Spong, Mark W., and Mathukumalli Vidyasagar. *Robot dynamics and control*. John Wiley & Sons, 2008.
5. Craig, John J. *Introduction to robotics: mechanics and control*. Vol. 3. Upper Saddle River: Pearson Prentice Hall, 2005.
6. Doebelin, Ernest O., and Dhanesh N. Manik. "Measurement systems: application and design." (2007).
7. Beckwith Thomas, G., and N. Lewis Buck. "Mechanical Measurements." (2008).
8. Ogata, Katsuhiko. "Modern Control Engineering, PHI Learning Pvt." *Ltd., New Delhi, India* (2009).
9. Tzafestas, Spyros G. "Intelligent robotic systems." *Electrical engineering and electronics* (1991).

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM734 Supply Chain Management**Course pre-requisites: Manufacturing Planning and Control****Course Objectives**

- To learn to apply tools & techniques of Supply Chain Management in real life industrial environment
- To think logically to design the tailor made new techniques which will enhance the effectiveness of the domain of Supply Chain Management.
- To design Tailor made Supply Chain Management for a typical requirement which will face the new challenges.

Course Outcomes

Upon successful completion of the course, students should be able

1. To describe the various concepts in SCM
2. To apply the various Tools and Techniques of Supply Chain Management in real life industrial environment.
3. To analyse the issues in SCM for a given case.
4. To design Tailor made Supply Chain for a typical requirement which will face the new challenges.

Course content:

Sr. No.	Details	Hrs.
Module 01	1. INTRODUCTION TO SUPPLY CHAIN MANAGEMENT: Current Business Scenario, Value Matrix Analysis, Evolution of SCM Function, Theme and Pillars of SCM System, How Supply chain works? Participants in the Supply Chain, Supply chain drivers, Supply chain structure	04
Module 02	2.SUPPLY CHAIN OPERATIONS: <u>2.1 Planning and Sourcing</u> Demand forecasting, Pricing and Promotional Impacts on demand, CPFR Concepts, CODP Concepts, Consensus Forecasting, Demand and Pricing Optimization <u>2.2 Making and Delivering</u> Product Design, Production Scheduling, Facility Management, Order Management, Delivery Scheduling, Distribution network design, channels of Distribution, Plant and warehouse location.	07
Module 03	3. MATERIALS MANAGEMENT IN SUPPLY CHAIN Scope, importance, classification of materials, Procurement, purchasing policies, vendor development and evaluation, Inventory control systems of stock replenishment, Cost elements New Supply Planning Paradigms, VMI, CMI, Green Channel supply, KM Model of Supplier Partnership, Multi-tier Supplier Partnerships Use of computers for materials function.	06
Module 04	4. LOGISTICS Logistics Evolution, 8 wings of Logistics, Distribution Network Systems, Warehousing and Inventory Cross-Docs, Multi-Modal Optimization, Inbound and Outbound handling, Containerization, TPL, FPL, MPL Partnering, Reverse Logistics	06
Module 05	5.TRANSPORTATION: Individual Freight and passenger modes, intermodal transportation and third party	05

	transportation services, economic social, and political roles of transportation, demand, cost and service characteristics of services, carrier selection and evaluation services, freight rate structure, Private International transportation, Ocean carrier management, port administration and regulation, costing and pricing issues of international transportation, logistics, cost transport mode choice, Dispatch decisions, routing decisions, routing Models, packaging to suit mode of Transport	
Module 06	6. SUPPLY CHAIN COORDINATION AND USE OF TECHNOLOGY The “Bullwhip” Effect, Supply Chain Coordination factors, Collaborative Planning, Forecasting, and Replenishment, supported information systems, E-Business and Supply Chain Integration, SCM systems Vendors, Types of Applications, Optimization Modeling, E-Business and Systems Integrations from ERP to SCM, KM, APS Systems, Further integration to CRM	07
Module 07	7.1 MEASURING PERFORMANCE: SUPPLY CHAIN METRICS Market Performance Categories, Framework for Performance Measurement, Internal Efficiency Metrics, Demand Flexibility Metrics, Product Development Metrics, Benchmarking and SCM SCORE modeling 7.2 TOTAL DISTRIBUTION COST ANALYSIS	07

Term Work:

Case Study /Course Project: Report of 10 - 15 pages on any topic from syllabus. Term work shall consist of minimum 06 assignments

Text Books:

1. Mohanty, Ph DRP, and Ph DSG Deshmukh. *Supply Chain Management (Theories & Practices)*. John Wiley & Sons, 2005.
2. Altekar, Rahul V. *Supply chain management: Concepts and cases*. PHI Learning Pvt. Ltd., 2005.
3. Shah, Janat. *Supply chain management: Text and Cases*. Pearson Education India, 2009.

Reference Books:

1. Christopher, Martin, and John Gattorna. "Supply chain cost management and value-based pricing." *Industrial marketing management* 34, no. 2, 2005.
2. Wisner, Joel D., Keah-Choon Tan, and G. Keong Leong. *Principles of supply chain management: a balanced approach*. Cengage Learning, 2014.
3. Shapiro, Jeremy. *Modeling the supply chain*. Nelson Education, 2006.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM735 Welding Process and Welding Technology**Course pre-requisites: Manufacturing Sciences****Course Objectives:**

The main objectives of the course are

- To introduce the students to the different type of welding and their application.
- To develop an ability to identify, formulate, and solve different type of welding problems.
- To understand the theory behind the selection of filler material for the different welding structure.

Course Outcomes:

At the end of the course the students shall be able to

1. identify and apply which type of welding method is required for different material and structure.
2. design the different weld structure and use of welding standard in design.
3. analyse heat flow and cooling rate in welding.
4. explain the power source, welding fluxes and coating required while welding.

Course Content

Module No	Details	Hrs
1	Evolution of welding; classification of welding processes; application of welding.	03
2	Design principles of welded structures, Welding symbols, standards and codes.	06
3	Welding methods – shielded metal arc welding, gas tungsten arc welding, gas metal arc welding, flux cored arc welding, submerged arc welding,	08
4	plasma arc welding, electroslag welding, electrogas welding, arc stud welding, synergic and pulsed welding, friction welding, Oxy-fuel gas welding, resistance welding, brazing, soldering.	05
5	Types of power source and their characteristics; Physics of welding arc – characteristics of arc, mode of metal transfer, forces acting on a molten droplet.	08
6	Welding fluxes and coatings - type and classification; Study and analysis of heat flow, cooling rates, models for welding heat sources.	06
7	Testing of welds, types of defect, causes and remedies of defect; NDT of welded joints; fracture and fatigue of welded structures, welding metallurgy, heat treatment of welds, effect of alloying materials.	06

Term work:-

At least 20 (twenty) solved problems/ case studies based on the above syllabus as per the module weightage shall be submitted as term work.

Textbooks/References:

- [1] O'Brien, Welding Handbook: Welding Processes, Part 1, Vol. 2, AWS, 2004.
 [2] J. F. Lancaster, The Physics of welding, Pergamon, 1986.
 [3] R. W. Messler, Principles of Welding, John Wiley and Sons, 1999.

- [4] O. Grong, Metallurgical modelling of welding, 2nd Ed, IOM Publication, 1997.
[5] V.M. Radhakrishnan, Welding technology and design, New age, 2002.
[6] J. A. Goldak, Computational welding mechanics, Springer, 2005.
[7] L.E Lindgren, Computational welding mechanics, Woodhead Publishing Limited 2007.
[8] Welding handbook by AWS (American Welding Society)

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM751 Advanced Internal Combustion Engine
Course pre-requisites: I.C. Engine

Course Objectives:

The students after studying these topics should be able to:

1. Understand fundamentals involved in internal engine combustion technology.
2. Understand construction and working principle of different types of engines and able to calculate work done and various efficiencies.
3. Test the performance of IC engines and plot their characteristics curves.

Course Outcomes:

Upon successful completion of the course, students should be able to:

1. Describe the constructional details and thermodynamics of I C Engine.
2. Apply the knowledge for testing and analyzing the engine performance parameters.
3. Analyze engine performance, fuel properties, and exhaust constituents of S I and C I Engines.
4. Evaluate the requirements of a modern engine for better economy and emissions.

Course Contents:

Module No.	Details	Hrs.
01	Need of Basic Engine Design: Design of I C engine components. Design of combustion chamber. Basic Engine Design Fundamentals, Developing a durable engine	04
02	Fuels and Bio-Diesel Fuels: Effect of fuel characteristic on engine performance. Introduction of biodiesel in the engines. Performance and emission analysis of I. C. Engines.	04
03	Engine Basic Theory Overall engine system parameters and configuration, Factors affecting combustion phenomenon. Engine Modification for alternative fuels. Engine development processes, Determining the number and layout of cylinders, Bore-to-stroke ratio optimization	08
04	Engine Block and Cylinder Head General design considerations, Design of Engine Block and Cylinder head. Block layout and design decisions, Cylinder head layout design, Material Selection, 2 Valve & 4 valve cylinder heads. Bolts loads and gasket design.	06
05	Crank Train and Valve train Design of Crank Train and Valve Train Mechanism, Function, Future trends in valve train design, Requirements, Materials – Piston and crankshaft. Recent trends in design of piston assembly – Piston, Piston rings, Piston pin, Connecting rod assembly and Crankshaft, Connecting-rod construction and development	07
06	Fuel Injection, Cooling & Lubrication Functional requirement, Fuel Filter, Types of Injectors, Pump-line-injector, injector system, Unit Injection, CRDI, Injection Pressure, Multiple Injections.	07

	<p>Cooling system: Cooling Circuits, Water Pump and Thermostat and its types, Cylinder head cooling, Cooling-jacket optimization</p> <p>Lubrication: Lubrication system performance analysis, Types & Layout, Requirement of Lubricants, Oil Filters, Oil Pan, Oil pump types. Oil deck design</p>	
07	<p>Recent Trends in Design of I C Engine Parts:</p> <p>Hybrid electric technology, Functional Requirement of intake and Exhaust system, Air Induction, Swirl and Turbulence, Swirl Generation, Air Filter, Intake Manifold, Exhaust Manifold, Turbochargers, EGR, EGR Cooler, Silencer etc, Part design philosophy.</p>	06

Term Work / Laboratory Work:

At least 2 assignments from each module

Text Books:

1. Sharma, R. P., and M. L. Mathur. "Internal Combustion Engine." (1980).
2. Obert, Edward F. "Internal combustion engines and air pollution." (1973).
3. Domkundwar, V. M. "A course in internal combustion engines." *Dhanpat Rai and CO.(P) Ltd* (2000).
4. Ganesan, V. *Internal combustion engines*. McGraw Hill Education (India) Pvt Ltd, 2012.

References:

1. Stone, Richard. *Introduction to internal combustion engines*. (1999).
2. Beohar S.L., *Internal Combustion Engine*,
3. Gill, Paul W., James H. Smith, and Eugene Ziurys. *Fundamentals of Internal Combustion Engines*. United States Naval Institute, 1952.
4. Heldt, Peter Martin. *High-speed combustion engines: design, production, tests*. Chilton Co., 1956.
5. Morse, Frederick T. *Power plant engineering*. Van Nostrand, 1963.
6. Maleev, Vladimir Leonidas. *Internal-combustion engines: theory and design*. 1945.
7. Taylor, Charles Fayette, and Edward Story Taylor. *The internal-combustion engine*. Vol. 1. International Textbook Co., 1961.
8. Heywood, J. B. "Internal combustion engine fundamentals/John B. Heywood."

Sr. No.	Examination	Module
1.	Test – I	Module 1, 2
2.	Test – II	Module 3, 4
3.	Endsem	Module 1 to 7

PE-BTM752 Computational Fluid Dynamics**Course pre-requisites: Fluid Mechanics****Course Objectives:**

This course is of high demand in job market due to its potential to help designers and developers of fluid and thermal systems without major experimentation. The objective of the course is to train the students with course fundamentals and hands on training with ANSYS CFD software.

Course Outcomes:

On successful completion of the course students will be able to

1. To describe need of modelling and simulation and its overall methodology of execution.
2. To solve a system of linear algebraic equation using standard direct and iterative technique.
3. To examine and formulate a thermal and fluid flow problem using numerical techniques.
4. To analyze outcome of thermal and fluid flow problems

Course Contents:

Module	Description	Hrs.
1	CFD Fundamentals: Modeling and Simulation Computational Fluid Dynamics - its Scope, Application, advantages and disadvantages. Overall methodology of CFD analysis -Preprocessing, Solver, Post processing	04
2	Mathematical Description of Physical Phenomenon: Concept of mathematical modeling, Basic conservation equation In differential and Integral form, General thermal and flow boundary condition, Mathematical nature of partial differential equation used in thermo-fluid analysis.	06
3	Numerical Solution of Linear Algebraic Equation: Direct Method – Matrix inversion, Gauss Elimination, LU decomposition. Iterative Method- Features of iterative techniques, Jacobi and Gauss Seidel Method, Relaxation method (SUR and SOR). Stability and convergence, Ill-conditioned system of equation and condition number,	06
4	Numerical Modeling of Heat Conduction: Steady One and two dimensional Conduction, Unsteady One and two Dimensional Conduction, Stability restrictions,	06
5	Numerical Modeling of Convection-Diffusion: Numerical treatment of convective terms- FOU, SOU, QUICK, Power law scheme. Steady One-dimensional and Two Dimensional Convection- Diffusion, Unsteady One-dimensional Convection-Diffusion, Unsteady Two- dimensional Convection-Diffusion	08
6	Incompressible Fluid Flow: Governing Equations, Complexities in solving flow problems, Determination of Pressure for Viscous Flow, SIMPLE, SIMPLER and PISO Algorithm	06

7	Turbulence Modeling: Introduction to Turbulence Modeling, Basic Theories of Turbulence Reynolds Time-Averaged Equations for Turbulent Flow, Different turbulence models.	06
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Term Work:

Term work shall consist of minimum **06 (Six)** assignments/tutorials

Recommended Books:

1. Versteeg H.K. and Malalasekera.W: “ An introduction to computational fluid dynamics-The finite volume method”, Prentice Hall
2. Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., “Computational Fluid Mechanics and Heat Transfer”, Hemishpere Publishing Corporation,.
3. Subas, V.Patankar, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation
4. Muralidhar, K. and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House.
5. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd.
- a. Niyogi.P. Laha M.K., Chakrabarty S.K.: “Introduction to Computational Fluid Dynamics”. Pearson Education, India.
6. Fletcher, C.A.J."Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer-Verlag

Sr. No.	Examination	Module
1.	Test – I	Module 1, 2
2.	Test – II	Module 3, 4
3.	Endsem	Module 1 to 7

PE-BTM753 Introduction to Cryogenics**Course pre-requisites: Thermodynamics, Heat and Mass Transfer****Course Objectives:**

The objectives of this course are:

1. **To explain** history, developments, pre-requisite principles, scope and applications of Cryogenic Engineering as a science of generation, retention and distribution of low extreme low temperature.
2. **To explain** and **illustrate** fundamental concepts and principles in the domain of behavior of engineering materials and fluids at cryogenic temperatures.
3. **To explain** and **illustrate** fundamental concepts and principles in the domain of cryogenic insulation, vacuum technology and safety aspects in Cryogenic Engineering.
4. **To explain and illustrate** fundamental principles, detailed features of arrangements, operation of various cryogenic cycles for liquefaction of gases and **evaluate** and **compare** performance parameters of practical cryogenic cycles and liquefactions systems with critical components involved.

Course Outcomes:

Upon successful completion of this course, the students should be able

1. **To explain** and **discuss** the history, developments, principles as well as scope and applications of Cryogenic Engineering.
2. **To explain and discuss** fundamental concepts and principles in the domain of behavior of engineering materials and fluids at cryogenic temperatures and **apply** to practical cryogenic systems to **evaluate** and **compare** their performance parameters.
3. **To explain and discuss** fundamental concepts and principles in the domain of cryogenic insulations, vacuum technology and safety aspects and **apply** to practical cryogenic systems to **evaluate** and **compare** their performance parameters.
4. **To explain** and **discuss** fundamental principles, detailed features of arrangements and operations of various cryogenic cycles for liquefaction of gases and **apply** to practical cryogenic systems to **analyse, evaluate** and **compare** their performance parameters.

Course Contents:

Module No.	Details	Hrs.
1.	Introduction to Cryogenic Engineering: Introduction, Historical background, Developments, Scope of application, Present areas involving Cryogenic Engineering, Role of Cryogenic Engineers, Principles of Thermodynamics, Heat Transfer, Momentum Transfer, Cooldown.	04

2.	<p>Low Temperature Properties of Engineering Materials: Properties of Solids:-Mechanical Properties, Thermal Properties, Electrical and Magnetic Properties of solids including metals and non-metals (insulators), Design considerations, Material selection criterion for Cryogenic Applications.</p> <p>Cryogenic Fluids:- P-V-T Behaviour of a Pure substance, T-s and T-h diagrams of a Pure substance, Properties of cryogenic fluids:- Fluids other than Hydrogen and Helium, Hydrogen , Helium.</p>	06
3.	<p>Gas Liquefaction Systems-I: Introduction, System performance parameters, The thermodynamically ideal system, Production of low temperatures:- Joule-Thompson effect, Adiabatic expansion. Simple Linde-Hampson system, Pre-cooled Linde- Hampson system, Linde dual pressure system, Cascade system, Claude system, Kapitza system, Heylandt system. Liquefaction systems for LNG, Comparison of liquefaction systems.</p>	08
4.	<p>Gas Liquefaction Systems-II: Liquefaction systems for Neon and Hydrogen:- Pre-cooled Linde-Hampson system for Neon and Hydrogen, Claude system for Neon and Hydrogen, Helium refrigerated Hydrogen liquefaction system, Ortho-Para Hydrogen conversion. Liquefaction systems for Helium:-Collins Helium liquefaction system, Simon Helium liquefaction system. Critical components of liquefaction systems:-Heat Exchangers, Compressors and expanders, Losses for real machines and effect on system performance, Effect of heat transfer to system.</p>	08
5.	<p>Cryogenic Insulations: Introduction, Heat transfer, Concept of apparent thermal conductivity, Different types of cryogenic insulations:-Expanded foam insulations, Gas-filled powders and fibrous insulations, Vacuum insulation, Evacuated powder and fibrous insulations, Opacified-powder insulations, Multilayer insulations, Comparison of insulations. Composite insulation, Adhesives and other materials, Placement of cryogenic insulation.</p>	06
6.	<p>Vacuum Technology: Importance of vacuum technology in cryogenic, Flow regimes in vacuum systems, Conductance in vacuum system, Components of vacuum system, Different types of vacuum pumps:- Mechanical vacuum pumps, Difussion pumps, Ion pumps, Cryopumping, Getters and sorption pumping, Vacuum gauges, Vacuum valves.</p>	06
7.	<p>Safety Aspects with Cryogenic Systems: Introduction, Physiological hazards, Suitability of materials and construction techniques, Explosions and flammability, Excessive pressure gas, Special considerations for Hydrogen and Oxygen gas, General safety principles, Safety checklist.</p>	04

Term Work:

At least one Assignment on each Module comprising analytical solution of numerical problems, Technical presentations based on Course contents, Analysis and Presentations on Reserch and Developmemnt work in the field of Cryogenic Engineering. Required attendance in Lectures and

Tutorials, involvement in academic activities related to course and overall conduct carry weightage in assessment of Term Work.

Text Book :

1. Barron, Randall F., *Cryogenic Systems*, 2nd edn., Oxford University Press, New York, 1985.

Reference Book :

1. Flynn, Thomas M., *Cryogenic Engineering*, 2nd edn, CRC Press, New York, 2005.

Sr. No.	Examination	Module
1.	Test – I	Module 1, 2
2.	Test – II	Module 3, 4
3.	Endsem	Module 1 to 7

PE-BTM754 Power Plant Engineering**Course pre-requisites: Thermal Systems****Course Objectives:**

The objectives of this course are:

1. **To explain** cost economics involved in different types of power generation plants.
2. **To explain** fundamental principles, detailed features of arrangements, operation and **evaluate** performance parameters of various power generation plants and their combinations.
3. **To explain** impact of power generation plants on environment and methods/ technologies adapted for improving efficiency and reducing the environmental impact.
4. **To develop** understanding for the national and global power generation scenario and to **analyse** a power generation system.

Course Outcomes:

Upon successful completion of this course, the students should be able

1. **To explain, interpret, evaluate and compare** cost economics involved in different types of power generation plants and **apply** for optimum selection of a power generation plant or combination of plants.
2. **To explain and compare** principles, detailed features of arrangements, operation and advantages of various power generation plants and **evaluate** their performance parameters.
3. **To explain and assess** impact of power generation technologies on environment and **adapt** techniques for improving efficiency and reducing the environmental impact.
4. **To develop** understanding for power generation scenario in the country with reference to World Power Generation and **apply** the acquired knowledge to **evaluate and compare** the performance parameters of different types of power generation plants or their combinations.

Course Contents:

Module No.	Details	Hrs.
1.	Economics of Power Plants: Load curve, load duration curve, various factors, and effect of fluctuating load on operation and design of the plant, methods of meeting fluctuating load. Selection of the generating equipment, load sharing, cost of electrical energy. Tariff methods. Performance and operating characteristics of Power Plants.	07
2.	Hydro Power Plants: Rainfall, Runoff and its measurement, Hydrograph, Flow Duration Curve, Mass Curve and Reservoir Storage Capacity. Classification of Hydro plants:-Run-off River Plant, Storage River Plant,	06

	Pumped Storage Plant.	
3.	Fluidized Bed Combustion: Regimes of Combustion, Circulating and Pressurized Fluidized Bed Combustion (FBC) system, Fluidized Bed Boilers-Features and Classification. Control of Nitrogen oxides.	06
4.	Nuclear Power Plants: Introduction to Nuclear Engineering:- Radioactive Decay, Half Life, Fission, Fusion, Nuclear materials. Thermal Fission Reactors and Power Plants:- PWR, BWR, Liquid Metal Reactors, Fast Breeder Reactors, Reactor Control.	06
5.	Diesel Power Plants: General Layout, Systems, Advantages and Disadvantages, Applications. Gas Turbine (GT) Power Plants: Types, Modifications, Performance Parameters and Comparison, Gas Turbine Material, Fuels, Applications, Current Scenario and Future Scope for GT Power Plants.	06
6.	Combined Cycle Power Generation: Thermodynamics of Combined Cycle Plants, GT-ST combinations and plant operation, Cogeneration, Mixed Cycle Power Generation, Benefits. Combined Power Generation Base Load and Peak Load Plants. Combination and Co-ordination of different types of Power Plants.	06
7.	Environmental Impact of Power Plants: Social and economical issues of power plants, Greenhouse effect, Acid precipitation- Acid Rain and Acid Snow, Dry deposition and acid fog, Thermal pollution, Air Pollution, Radiation from Nuclear Power Plants, Coal storage, In-plant handling of coal, Ash handling systems. Dust collectors. Flue Gas Desulphurization (FGD) methods. Power Generation:- Global and Indian Scenarion.	05

Term Work:

At least one assignment on each module comprising analytical solutions of numerical problems based on course contents. Required attendance in Lectures and Tutorials, involvement in academic activities related to the course and overall conduct carry weightage in assessment of Term Work.

Text Books:

1. Nag, P. K., *Power Plant Engineering*. Tata McGraw-Hill Education, 2002.
2. Ei-Wakil, M.M, *Power Plant Technology*, McGraw Hill, 2016,
(<https://engineeringstudymaterial.net/ebook/power-plant-technology>)
3. Domkundwar, A. S., *Power Plant Engineering*, Dhanpat Raj & Sons, India, 2000.
4. Sharma, P. C. *Power Plant Engineering*. SK Kataria and Sons, 2009.
5. Rajput, R. K., *Power Plant Engineering*, Laxmi Publication (P) Ltd, 1995.
6. Dr, Yadav, R., *Steam and Gas Turbines and Power Plant Engineering*, Central Publishing

House, 7th Revised edn., 2012.

Reference Books:

1. Morse, Frederick T., *Power plant engineering*, Van Nostrand, 1963.
2. Potter, Philip J. *Power plant theory and design*. Ronald Press Company, 1959.
3. Weisman, Joel, and Eckart Roy. *Modern Power Plant Engineering*, 1985.
4. Bennet, John Donald and Thomson James Robert, *The Elements of Nuclear Power*, 1989.
5. Elliott, Thomas C., *Standard Handbook of Power Plant Engineering*, 1989.

Sr. No.	Examination	Module
1.	Test – I	Module 1, 2
2.	Test – II	Module 3, 4
3.	Endsem	Module 1 to 7

PE-BTM755 Automobile Engineering**Course pre-requisites: I.C. Engine****Course Objectives:**

- Automobile engineer must be familiar with this course to know commercial considerations, such as economics, marketing, and sales.
- Students must be familiar with different operations of spark ignition engines and compression ignition engines.
- This syllabus is associated with the engine and includes belt drives, air conditioning, and the starting and charging systems.
- Students must be done analysis of both manual and automatic transmissions, driveshaft design, and four- and all wheel-drive systems.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To explain knowledge regarding analytical design of the complete motor vehicle, Vehicle Body Engineering and current motor vehicle design.
2. To evaluate the vehicle performance and different losses or resistances occur during driving the vehicle
3. To explain the different mechanisms of the vehicle
4. To design the different vehicles, and the components required

Course Contents:

Sr. No.	Details	Hrs.
Module 01	<p>Introduction: Classification of automobiles.</p> <p>Automobile power plant: constructional features of different types of engines used in Automobiles, their characteristics, study of various engine components and their materials.</p> <p>Vehicle performance: Tractive force, Tractive force Vs Vehicle speed, resistance to motion of the Vehicle – Rolling and gradient resistance, power requirement for acceleration and gradeability, maximum acceleration for front wheel drive – Rear wheel drive – four wheel drive Vehicles, selection of suitable real axle and gear ratios.</p> <p>Maintenance and troubleshooting aspects of: clutches, gear box, brakes</p>	08
Module 02	<p>Transmission Systems: Study of Propeller shaft and universal joint, live axle and differential</p> <p>Steering and front axles: Steering geometry, Steering requirements, Steering linkages and Steering gears, over Steer and under Steer, cornering power, reversibility of Steering gears, types of front axles their constructions, troubleshooting and remedies</p>	06
Module 03	<p>Suspension systems: objects of Suspension, basic requirements, types of Suspension, shock absorbers</p> <p>Wheels and tyres: requirements of Wheels and tyres, constructional features, types of tyres, application to ride and stability, troubleshooting and remedies.</p> <p>Electrical system: study of different types of batteries, study of electronic ignition system, study of charging system, study of starting system.</p>	06

	Lighting system: types of lamps, Energy demands of lighting system, construction and types of head lamps.	
Module 04	<p>Vehicle Body Design: importance of body design, material for body constructions – styling forms – coach and bus body style, layouts of passenger cars, bus and Truck bodies. Aerodynamic drag – aerodynamic lifts, pitching moments, side force, yawing moments and Rolling moments.</p> <p>Basic dimensions: geometrical relations to driver seat, dimensions of foot and pedal control, passenger seats, vehicle dimensions and visibility.</p> <p>Chassis types and structure types: open semi integral pedal and integral Bus structures.</p> <p>Frames: function and types loads on frames, load distribution of structure.</p>	06
Module 05	<p>Vehicle vibration and dynamics: types of vibration, vibration control, effect of vibration on human body, Driver's comfort and passenger's comfort vehicle vibration with single degree of vibration.</p> <p>Different accessories used in vehicles: Electric Horn, Wipers, Fuel pump, power operated windows, etc.</p>	08
Module 06	<p>Vehicle maintenance and servicing : Importance of vehicle maintenance, primitive maintenance, break down maintenance, corrective maintenance, overhaul major and minor, engine and chassis lubrication, types of lubricants.</p> <p>Recent trends in automobile: Electronic control module(ECM), Operating modes of ECM (Closed loop and Open Loop), inputs required and output signals from ECM, electronic spark control, air management system, ideal speed control.</p>	07
Module 07	<p>Multipoint fuel injection (MPFI) system and Single point fuel injection, electronic fuel injectors: principal of operations, construction, working and application of temperature sensors, inductive sensors, position sensors, pressure sensors, knock sensors, hot wire and thin film air flow sensors, vortex flow/ turbine fluid sensors, optical sensors, oxygen sensors, light sensors, methanol sensors, and rain sensors. New developments in sensor technology.</p>	07

List of assignments and experiments:

Assignments and laboratory experiments of (any 8)

1. Study of ignition and charging system.
2. Study of starting system, lighting system and battery.
3. Study of suspension system.
4. Study of basic dimension and vehicle layout.
5. Study of computer control engine.
6. Study of wheels and tiers.
7. Study of vehicle maintenance.
8. Study of different drives.
9. Study of steering system.

Term work :

Term work shall consist of minimum eight experiments, assignments.

Text Books:

1. Singh, Kirpal. *Automobile engineering*. Standard publishers, 1994.
2. Giri, N. K. *Automobile mechanics*. 2013.
3. Banga, T. R., and Natthana Simha. *A textbook on Automobile Engineering*. Khanna Publ., 1987.
4. Steed W., *Principle of vehicle dynamics*

5. Gupta, R. B. "Automobile engineering." *Satya Prakashan* (1993).

References:

1. Reyat H.S., *The Automobile*, S.Chand and Co., 2004.
2. Pawlowski, Janusz, and Guy Tidbury. *Vehicle body engineering*. Business Books, 1969.
3. King, Dick H. *Computerized engine controls*. Delmar Publishers Inc., 1990.
4. Crouse, William H., and William Harry Crouse. *Automotive mechanics*. Tata McGraw-Hill Education, 1982.
5. Garrett, Thomas Kenneth, Kenneth Newton, and William Steeds. *Motor vehicle*. Butterworth-Heinemann, 2000.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

PE-BTM756 Renewable Energy Sources and Utilization**Course pre-requisites: Thermal Systems****Course Objectives:**

To understand the importance of renewable energy and its utilization to satisfy the ever increasing thermal and electrical energy needs of humankind. At the same time be aware of the environmental aspects of these resources.

Course Outcomes:

Upon successful completion of the course, students should be able

1. To apply the fundamental knowledge of heat transfer and fluid mechanics for harnessing renewable energy sources like solar, wind and other sources.
2. To calculate and analyze energy production from liquid flat plate collectors, concentrated collectors, photovoltaic cells and wind energy.
3. To identify and select appropriate renewable energy technology to meet the demand.
4. To identify techniques in extraction and utilization of ocean and geothermal energy.

Course contents:

Sr. No.	Description	Hrs.
1	ENERGY REQUIREMENT - OF INDIA AND THE WORLD: 06 Present energy scenario, conventional energy sources- World's Production and reserves, India's production and reserves. Demand side management of energy. Need and role of renewable energy.	6
2	SOLAR ENERGY I: Terrestrial and extra-terrestrial solar radiation. 10 Instruments for measurement of solar radiation. Analysis of liquid flat plate collector, Use of selective coatings to enhance performance. Selection of suitable system to satisfy hot water requirements of any application. Concentrating collectors, solar ponds, solar distillators, solar cooker, solar air heaters, solar driers, solar thermal power system, solar energy storage (Focus on design for specific needs), Solar refrigeration and air-conditioning. Economics of Solar systems.	10
3	SOLAR ENERGY II: Photovoltaic energy conversion, solar cells, Selection of PV system to match application.	03
4	WIND ENERGY: History, principle of wind power, Betz model. Wind maps, Site selection for wind farms. Wind mills- Design parameters of components, Electrical Power Generation Subsystem. Operational issues, Newer designs of windmills. Application of wind energy.	06
5	HYDRO-POWER: Prospects of small hydropower, mini and micro power systems, hydropower conversion devices-Turbine, status of mini and micro hydel in India. OCEAN ENERGY: Types of ocean energy sources, OTEC cycles closed and open. Comparison with normal thermal power cycles. Ocean waves-wave motion, Wave energy conversion devices. Tidal Power- Formation and causes of tides, site selection, turbines selection.	08
6	GEOHERMAL ENERGY: History and future, origin and types of geothermal energy regions, dry rock and hot Aquifer analysis, vapor dominated and liquid nominated geothermal systems, operational and environmental problems.	03

7	<p>BIOMASS ENERGY: Various forms of biomass as a potential energy source, Bio-fuel production processes, Gasifiers, principle, construction and design, Types of bio gas plants individual and community biogas plants, Sizing of biogas plants, energy plantation.</p> <p>CHEMICAL ENERGY SOURCES: Fuel cells-principle, classification, advantage and disadvantage, application and recent development.</p>	08
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Term work:

Term work shall consist of a selection of any 5 experiments given below:

1. Measuring solar radiation using Pyranometer.
2. Measuring length of shadow and comparing with calculated length with reasons for difference.
3. Performance of solar liquid flat plate collector, plotting in Hottel Whillier Bliss format.
4. Use of Box type cooker and compare with concentrating type Sievert Cooker.
5. Solar PV panel-characteristics.
6. Measuring performance of Wind Turbine available in SPCE.
7. Survey of energy use in households

And a mini project involving fabrication of working model of device to extract energy of the wind or wave energy.

Recommended Books:**Text Books:**

1. Sukhatme, K., and Suhas P. Sukhatme. *Solar energy: principles of thermal collection and storage*. Tata McGraw-Hill Education, 1996.
2. Tiwari, Gopal Nath. *Solar energy: fundamentals, design, modelling and applications*. Alpha Science Int'l Ltd., 2002.
3. G.D. Rai, *Non-conventional Energy Sources*. Khanna Publishers.

References

1. Kishore, V. V. N., ed. *Renewable energy engineering and technology: principles and practice*. The Energy and Resources Institute (TERI), 2010.
2. Boyle, Godfrey. *Renewable Energy: Power for a Sustainable*. Oxford University Press, USA, 1996.
3. Twidell, John, and Tony Weir. *Renewable energy resources*. Routledge, 2015.
4. Goswami, D. Yogi, and Frank Kreith, eds. *Handbook of energy efficiency and renewable energy*. Crc Press, 2007.
5. Tripathi A.K., *Multiple Choice Questions on Renewable Energy*, 2001.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

OE-BTM711 Enterprise Resource Planning (ERP)**Course pre-requisites: General Engineering****Course Objectives:**

This course presents an introduction to ERP and related technologies. The course discusses ERP Manufacturing Perspective and ERP modules. The course will teach the learners the ERP implementation lifecycle, emphasis on ERP benefits and introduces the ERP tools.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Discuss basic needs of ERP as management information system
2. Explore applications of technologies like Business Processing Reengineering (BPR), Supply Chain Management (SCM), Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System, etc.
3. Identify proper ERP tools and define benefits of ERP.
4. Investigate the challenges, constraints, needs, pitfalls, myths of implementation of ERP

Course contents:

Sr. No.	Description	Hrs.
1	Introduction: Enterprise – An Overview, Integrated Management Information, Business Modeling, Integrated Data Model	
2	ERP and Related Business Technologies: Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM), Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System	
3	MRP - Material Requirement Planning, BOM - Bill Of Manufacturing Material, MRP - Perspective Manufacturing Resource Planning, DRP – Distributed Requirement Planning, PDM - Product Data Management	
4	ERP modules: Finance, Plant Maintenance, Quality Management, Materials Management Benefits of ERP: Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality, Costs, Improved Information Accuracy and Design-making Capability	
5	ERP Implementation Lifecycle: Pre-evaluation Screening, Package Evaluation, Project Implementation Planning Phase, Gap Analysis, Reengineering, Lifecycle Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Postimplementation (Maintenance mode)	
6	ERP and e-Business: Enterprise resource planning the E-business Backbone Enterprise architecture, planning ERP usage in Real Architecture world, Future of ERP applications, E-Procurement, E-Governance	
7	Introduction to ERP tools	

Term work:

Term work shall consist of assignments based on each module.

Text Books:

1. Alexis Leon, Enterprise Resource Planning, Tata McGraw Hill (2012).
2. Ravi Shankar & S. Jaiswal, Enterprise Resource Planning, Galgotia.

Reference Books:

1. Annetta Clewto and Dane Franklin, Guide to Planning ERP Application, , McGraw-Hill, 1997
2. Jose Antonio, The SAP R/3 Handbook, McGraw – Hill
3. Dr. Ravi Kalakota, E-Business Network Resource planning using SAP R/3 Baan and Peoplesoft : A Practical Roadmap For Success

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

OE-BTM712 Introduction to Research Methodology

Course pre-requisites: General Engineering, Communication Skills

Course Objectives:

1. To learn research methodology
2. To learn research methodology tools and techniques
3. To learn research report writing

Course Outcomes:

Upon successful completion of the course, the students should be able to

1. understand the basics of Research Methodology
2. understand the Tools and techniques in Research Methodology
3. use the knowledge of data collection methods
4. write the research report

Course Contents:

Sr. No.	Details	Hrs.
Module 01	Definition of research: Research – Definition; Types of Research methods Pure and applied research. Descriptive and explanatory research, Qualitative and quantitative approaches	03
Module 02	Research procedure: Formulating the Research Problem, research design including sample Design, Sample size. Considerations in selecting research problem	06
Module 03	Literature survey, Guidelines for Literature survey	06
Module 04	Data Collection methods: Interview, experimental methods, case study	09
Module 05	Regression Equation and Curve fitting	06
Module 06	Hypothesis tests: z test , F test , t Test, Chi Sq test	06
Module 07	Outcome of research: Preparation of the Report on conclusions reached. Testing validity of research outcomes. Suggestions and recommendations, identifying future scope.	06

Term Work:

Term work shall consist of one assignment on each module.

Text Books:

1. Kothari C R, Research Methodology, Wiley Eastern
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

OE-BTM714 Introduction to Micro Electro Mechanical Systems**Course pre-requisites: Engineering sciences****Course Objectives**

1. To introduce basic concepts of MEMS and its applications.
2. To introduce sensors and actuators in Micro-domain.
3. To study modelling and simulation techniques for various applications.
4. Apply knowledge of micro fabrication techniques and applications to the design and manufacturing of an MEMS device or a micro system

Course Outcomes: Learner will be able to...

1. Select appropriate sensors and actuators for a given MEMS application.
2. Select a micro-fabrication technique for a specific MEMS fabrication process.
3. Model and simulate a given MEMS system
4. Design MEMS

Course content:

Sr. No.	Description	Hrs.
1	Introduction to MEMS & Applications <ul style="list-style-type: none"> • Introduction to Micro-Electro-Mechanical Systems, • Applications and Materials, • Advantages & Disadvantages of Micro-sensors, and micro-actuators. 	6
2	Sensors and Actuators in Micro-domain <ul style="list-style-type: none"> • Concept of Sensors & Actuators, • Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys • Comb Drive Actuation & Sensing. Micro-mechanisms, Air-Bag Sensors. 	6
3	Fabrication Methods Microfabrication Methods (VLSI Techniques) <ul style="list-style-type: none"> • Positive and Negative Photoresists, • Bulk Micromachining, • Surface Micromachining, • Etching (Isotropic and Anisotropic), • Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques. 	6
4	3D High Aspect Ratio Fabrication Techniques <ul style="list-style-type: none"> • LIGA, • AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography etc 	6
5	Modelling and Simulation Techniques <ul style="list-style-type: none"> • Scaling Laws, Governing Equations • Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal 	6

	Laws, Fluid Flow Analysis.	
6	Characterization Techniques Topography Methods (Optical, Electrical and Mechanical Methods) • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes), SPM (Scanning Probe Microscopes), AFM (Atomic Force Microscopes) Mechanical Structure Analysis	6
7	Introduction to Advances of MEMS and Nanotechnology • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS), • Domestic and Industrial Applications of nanotechnology • Social and Ethical Implications of nanotechnology in Society	6

Term Work/Tutorial

1. Assignments on each module
2. Case studies on applications of Micro-electromechanical Systems
3. Seminar on recent advances in Micro-electromechanical Systems
4. Exercises on layout of Integrated circuits on L-Edit software

Recommended Books:

1. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim “Microsensors MEMS and Smart devices”, John Wiley and sons, Ltd.
2. Nadim Mulaf and Kirt Williams, “An Introduction to Microelectromechanical systems Engineering”, Artech House.
3. Nicolae Lobontiu and Ephrahim Garcia, “Mechanics of Microelectromechanical systems”, Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, “Silicon Processing for the VLSI era Volume -1 Technology”, Lattice press.
5. Vijay K. Varadan, K.J. Vinoy and S. Gopalkrishnan, “Smart Material Systems and MEMS: Design and Development Methodologies”, John Wiley and sons Ltd.
6. Bhushan, “Springer Handbook of Nanotechnology”, Springer Inc.

Sr. No.	Examination	Module
1.	T-I	1,2
2.	T-II	3,4
3.	End Sem	1 to 7

OE-BTM715 Solar and Wind Technology**Course pre-requisites: General Engineering****Course Objectives:**

In India, solar and wind power based system are finding wide acceptance. Government is also promoting their use to meet the increasing demand of energy. The objective of the course to provide fundamental knowledge of this domain and equip students to design, develop and work in this area.

Course Outcomes:

On successful completion of the course students will

1. have knowledge of fundamentals of solar and wind as a source of energy,
2. understand the working principle, components, system performance of solar and wind based power generating system,
3. be able to select and recommend an optimum power solution to an application,
4. be able to design a solar powered system.

Course Contents:

Module	Description	Hrs.
1	<i>Fundamental of Solar Radiation:</i> Properties of sunlight. Absorption by the atmosphere. Calculation of solar irradiance at surfaces.	04
2	<i>Solar Thermal:</i> Thermodynamic description of solar collectors. Optical properties of solar collectors and technologies for fabrication. Solar thermal systems for different applications. Storage of solar generated heat and its economics.	04
3	<i>Solar Cells and Modules:</i> Function of a solar cells from semiconductor physics. Different solar cell technologies and fabrication methods. <i>Solar cell systems</i> - System components and their functions. Calculating output and dimensioning of solar cell systems. Concentrated sunlight and solar power (CSP). Properties of optical concentration systems. Solar cells in concentrated sunlight.	04
4	<i>Hybrid Systems:</i> Combinations of solar thermal and solar cell systems. Overview of different applications. Design of a solar powered system for a specific application.	04
5	<i>Fundamental of Wind Energy:</i> Characteristics of different state of wind, Fluid mechanics of power generation from wind, Power characteristics.	04
6	<i>Technology of Wind Power:</i> Types of wind turbine- Horizontal axis and vertical axis, and their functioning Subsystems - Nacelle, Rotor, Hub and blades	04

7	<p>Development in Solar and Wind Technology</p> <p>Assessment of present issues, Assessment of economics of solar and wind projects, Improving performance & reliability and reducing cost, Novel designs, Environment and Government Policy.</p>	04
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Term work: Assignments containing numerical problems based on each module.
Seminar based on recent advances in subject.

Recommended Books:

1. John Twidell and Tony Weir, “*Renewable Energy Resources*”, John Wiley & Sons, 8ed.
2. Mukund R Patel, “*Wind and solar powersystem*”, CRC Press, 2ed.
3. Johnson, G.L., *Wind Energy Systems*, Prentice Hall, London,
4. Yogi Goswami, D., Kreith, F., and Kreider, J.F., *Principles of Solar Engineering*, Taylor & Francis, 2000
5. Sukhatme S.P, "Principles of Solar Energy Collection and Storage", Tata-McGraw Hill

Sr. No.	Examination	Module
1.	Test – I	Module 1, 2
2.	Test – II	Module 3, 4
3.	Endsem	Module 1 to 7

OE-BTM716 Internet of Things (IOT)

Course pre-requisites: General knowledge of networking, sensing, databases, programming, and related technology

Course Objectives:

Upon successful completion of the course, students will be

- Explored to the interconnection and integration of the physical world and the cyber space.
- They are also able to design & develop IOT Devices.

Course Outcomes:

After successful completion of the course student should be able to

1. Describe the theory related to Internet of things
2. Apply theoretical knowledge of IOT in practice
3. Select the hardware & software for different applications.
4. Develop an application using IOT hardware & software

Course Content:

Module No	Details	Hrs.
Module 01	Introduction Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain, Industrial Internet of things (IIOT) etc.	04
Module 02	Enabling Technologies of IOT Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	04
Module 03	Programming the Microcontroller for IOT Cloud computing and IOT –Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Ethernet	04
Module 04	Resource Management Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	04
Module 05	IOT PROTOCOLS Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors, Integrating with Application Platform	04
Module 06	IOT Platforms Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	04

Module 07	Challenges & Opportunities of IOT New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT devices	04
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Term Work:

- It consists of **at least one** tutorial and/or assignments and/or hands-on exercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to IOT
- Mini Project

TEXT BOOKS:

1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011

REFERENCE BOOKS:

1. Charalampos Doukas , “Building Internet of Things with the Arduino”, Create space, April 2002

Internet of Things (IOT) Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of IOT, learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Test 1: 20% (Theory paper)

Test 2: 20% (Theory paper)

End-semester evaluation: 60%

Sr. No.	Examination	Module
1.	Test – I	Module 1, 2
2.	Test – II	Module 3, 4
3.	Endsem	Module 1 to 7

OE-BTM717 Introduction to Augmented Reality**Course pre-requisites:** General knowledge of CAD Modelling**Course Objectives:**

Upon successful completion of the course, students will be

- Explore the basic concepts of Augmented Reality.
- They are also able to design & develop AR application.

Course Outcomes:

After successful completion of the course student should be able to

5. Describe the theory related to Augmented Reality
6. Apply theoretical knowledge of AR in practice
7. Select the hardware & software for different applications.
8. Develop interactive augmented reality applications for both PC based mobile devices using a variety of novel input devices

Course Content:

Module No	Details	Hrs.
Module 01	Introduction History of AR, Basics of Augmented Reality, Architecture/Framework, Marker & Marker less AR	06
Module 02	Enabling Technologies of Augmented Reality Mobile, Camera, webcam, Cloud Computing, Unity, SDK, Augment, display of digital content, tracking, registration, recognition, rendering etc.	06
Module 03	Applications of AR in Industries & Education Remote Maintenance, Product Development, Logistics, NDT, Architecture, civil building works & training, Manufacturing resource planning, Sales & marketing, Assembly, education etc.	06
Module 04	Lighting and Illumination Issues in AR Conversion of CAD Model to AR Model	06
Module 05	Hardware HOLOLENS INTERFACE	06
Module 06	Integration scenarios of AR with other IT Technologies <ul style="list-style-type: none"> • IOT+ AR Integration 	06
Module 07	Challenges & Opportunities of AR New business & Revenue models, Technological challenges faced by AR	06

Term Work:

- It consists of **at least one** tutorial and/or assignments and/or hands-on exercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to AR
- Mini Project

TEXT BOOKS:

1. Cawood , Augmented Reality A Practical Guide Paperback – 2008

REFERENCE BOOKS:

1. Tobias Höllerer, Dieter Schmalstieg, Augmented Reality: Principles and Practice

Augmented Reality (AR) Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of AR, learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Test 1: 20% (Theory paper)

Test 2: 20% (Theory paper)

In-semester evaluation: 60%

Sr. No.	Examination	Module
1.	Test – I	Module 1, 2
2.	Test – II	Module 3, 4
3.	Endsem	Module 1 to 7

OE-BTM718 Fundamentals of AI and Machine Learning**Course pre-requisites:** Mathematics, Knowledge of programming language (Python preferred)**Course Objective:**

The students after studying these topics should be able to

1. understand applications of Artificial Intelligence and Machine Learning for engineering applications
2. apply suitable algorithms for simple engineering problems

Course Outcomes:

Upon successful completion of the course, students should be able to

1. discuss applications of Artificial Intelligence for engineering problem solving
2. apply fundamental concepts in machine learning and select popular machine learning algorithms for engineering problem solving
3. compose computer code for solving problems using machine learning algorithms
4. explain advanced machine learning concepts such as Neural Network, Reinforcement Learning.

Course Content:

Module No.	Details	Hrs.
01	Fundamental Concepts of AI, Agents, Environments, General Model, Problem Solving Techniques, uninformed search techniques, Heuristic search, adversarial search and game trees	4
02	Knowledge representation, Propositional and predicate calculus, semantics for predicate calculus, inference rules	2
03	Introduction to Machine Learning Learning algorithm: Supervise and Unsupervised Learning, Regression Algorithms Classification Algorithms: Logistic, Bayes, NN Classifiers Clustering: K-Means, DBSCAN, and Hierarchical Clustering Linear regression, Decision trees, overfitting, Instance based learning, Feature reduction, Collaborative filtering-based recommendation	6
04	Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM	4
05	Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network, deep learning	6
06	Clustering: k-means, adaptive hierarchical clustering	4
07	Introduction to Reinforcement Learning	2

Term Work/Laboratory:

- Journal work shall consist of e-folder with computer code for solution to problems based on each module.
- Seminar
- Mini-project

Text Books:

1. Tom Mitchell, Machine Learning, First Edition, McGraw- Hill (1997).
2. Stuart Russel and Peter Norvig, Artificial Intelligence – A modern approach, Pearson (2015)
3. Ethem Alpaydin, Introduction to Machine Learning, PHI (2015).
4. Gopal M., Applied Machine Learning, McGraw Hill (2018)

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

OE-BTM719 Value Engineering

Course pre-requisites: General Engineering

Course Objectives:

1. To understand and analyse the theory and methodology of Value Engineering with the Guidelines
2. To understand the step by step application of the technique to the current industrial problems.
3. To provide the knowledge about Value engineering Principles, the various models and implementation method, which are adopted in the industries.

Course Outcomes:

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

1. To understand the concepts of value engineering, identify the advantages, applications.
2. To analyze the function, approach of function and evaluation of function. Determine the worth and value.
3. Appraise the value engineering operation in maintenance and repair activities.
4. To improve management skill

Course Content

Module No.	Course content	Hours
1	What is Value Engineering Myths on Value Engineering, History of Value Engineering. Why Value Engineering. Understanding Value and different types of Values, Introduction of Function and its importance in Value creation	04
2	Identifying Functions and Job Plan Methodology, Projects identification and Techniques	04
3	Function Analysis System Technique. (FAST) with exercises, Function – Cost – Worth. (FCW)	04
4	Team building and its Role in success of projects, Creativity & Innovation. Different methodologies for Ideas generation	04
5	Evaluation of Ideas and various Techniques, Implementation of Ideas and Logical conclusions of projects	04
6	Hands on practice on Implementation of Projects by students	04
7	Value engineering Projects in Construction Industry, Manufacturing Industry and Service Industries	04

Distribution of Term Work marks shall be as follows: (total 25 marks).

1. Case study presentation : 15 marks
2. Group Discussion : 05 marks
3. Attendance: 05 marks

Text Book:

1. Anil Kumar Mukhopadhyaya, “Value Engineering: Concepts Techniques and applications”, SAGE Publications 2010

References:

1. Alphonse Dell’Isola, “Value Engineering: Practical Applications for Design, Construction, Maintenance & Operations”, R S Means Co., 1997.
2. Richard Park, “Value Engineering: A Plan for Invention”, St. Lucie Press, 1999.
3. Del L. Younker, “Value Engineering analysis and methodology”, Marcel Dekker Inc, New York, 2004.
4. Miles, L.D., “Techniques of Value Analysis and Engineering”, McGraw Hill second Edition, 1989.
5. Khanna, O.P., “Industrial Engineering and Management”, DhanpatRai& Sons, 1993.
6. Anil Kumar Mukhopadhyaya, “Value Engineering Mastermind: From concept to Value Engineering Certification”, SAGE Publications, 2003.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

OE-BTM720 Fire and Safety Management in Industry
Course pre-requisites: General Engineering

Course Objectives:

1. To understand Fire, its character knowledge areas and tool – techniques Fire Management.
2. Understand the role of Fire Management in an Industry.
3. Develop an understanding of various techniques used to avoid fire and safety techniques
4. To understand various regulation norms and their safety requirements

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe the basic knowledge of Fire Management.
2. To describe the various tools and Techniques used in Fire Management.
3. To understand the various precautionary concepts and Tools in Fire Management for Industries.
4. To investigate and assess fire regulatory norms and inspect the study cases.

Course Content:

Module No	Details	Hrs
1	Introduction: Introduction to Industrial study, safety management in Chemical industry, Hazard identification and analysis.	06
2	Accident Prevention principles & investigation, Job safety analysis, Behavioral based safety, Process safety management, Various regulatory norms existed in industrial fire & safety, Government regulations, authorities & permissions	06
3	Fire management system, effective fire safety, tools & techniques, ISO 14001 – 2015 – Environment management system, Protect and sustainability, ISO 45001 – 2018 – Occupational Health & safety management system, Personal Protective equipments	08
4	Various Industrial processes of fire potential, Nature of Fire and fire protection, Sulfuric acid plant process, sulfuric acid plant visit Safety norms in acidic plant & industry	08
5	Governing body, work permit, inspection, authority, Hazard prevention plan, disaster management: Disaster preparedness and relief plan, emergency control plan	
6	Industrial safety management, Fire safety, Fire Prevention, Principles, Techniques and mitigation, Human behavior in disasters, Mass control techniques	08
7	Types of fires, techniques of different fire extinguishers, Fire extinguishing Demonstration, safety and fire audit, Course evaluation	06

Term work

1. Assignments based on above modules
2. Seminar based on recent advances in the course
3. At least one Case study conducted at industry

Teaching Methods:

1. The course will use the following pedagogical tools:
2. Discussion on concepts of fire management in an organization.
3. Understanding chemistry of fire and environmental issues.
4. Case studies of great disasters, causes and faults and negligence, fire Management tools and techniques.
5. Projects/ Assignments/ Quizzes/ Class participation etc.

References:

1. A. Maurice Jones, Jr. Fire Protection Systems, Jones & Barlett Publishers, 2016
2. Eugene Meyer, Chemistry of Hazardous Materials, Pearson Publishers, 2013
3. D S S Ganguly & C S Changeriya, Fire engineering, Fire technology, Chetan Prakashan, , 2011.

Sr. No.	Examination	Module
1	T-I	1 to 2
2	T-II	3 to 4
3	End Sem	1 to 7

OE-BTE702 Engineering Economics

Course pre-requisites: Basics of Project Management, statistics and mathematics, general knowledge about working of organizations

Course Objectives:

1. Learn the basic concepts of engineering economics.
2. Understand some engineering economics methods for solving problems of present worth, annual cost, rate of return, payback, break even, benefit cost ratio, etc.
3. Learn to evaluate the cost effectiveness of engineering projects on the basis of their economic viability.
4. Understand the concepts of depreciation / appreciation of assets / resources and its impact on their value.

Course Outcomes: Students will demonstrate the ability to

1. Apply appropriate engineering economics methods for solving problems of present worth, annual cost, rate of return, payback, break even, benefit cost ratio, etc.
2. Evaluate the cost effectiveness of engineering projects on the basis of their economic viability and draw inferences for the investment decisions.
3. Calculate depreciation / appreciation of assets / resources to assess its impact on present or future value.

Course Contents:

Unit	Contents	Hrs.
1	Introduction <ul style="list-style-type: none"> • Economics: Flow in an economy, Law of Supply and Demand, • Concept of Engineering Economics: Definition, Scope, Types of Efficiency • Elements of Costs: Marginal Cost, Marginal Revenue, Sunk Cost, Opportunity Cost • Break-Even Analysis, Profit / Volume Ratio 	03
	Elementary Economic Analysis <ul style="list-style-type: none"> • Basics, Material Selection for a Product, Building Material Selection • Process Planning / Process Modification 	03
2	Interest Formulas and Their Applications <ul style="list-style-type: none"> • Introduction, Time Value of Money • Interest Formulas: Single Payment Compound Amount, Single-Payment Present Worth Amount, Equal-Payment Series Compound Amount, Equal-Payment Series Sinking Fund, Equal-Payment Series Present Worth Amount, Equal-Payment Series Capital Recovery Amount, Uniform Gradient Series Annual Equivalent Amount, Effective Interest Rate • Bases for Comparison of Alternatives 	03
3	Present Worth Method of Comparison <ul style="list-style-type: none"> • Basics, Revenue-dominated Cash Flow Diagram, • Cost-dominated Cash Flow Diagram Future Worth Method <ul style="list-style-type: none"> • Basics, Revenue-dominated Cash Flow Diagram 	06

	<ul style="list-style-type: none"> • Cost-dominated Cash Flow Diagram <p>Annual Equivalent Method</p> <ul style="list-style-type: none"> • Basics, Revenue-dominated Cash Flow Diagram • Cost-dominated Cash Flow Diagram • Alternate Approach <p>Rate of Return Method.</p> <p>Advantages and disadvantages of each method.</p>	
4	<p>Replacement and Maintenance Analysis</p> <ul style="list-style-type: none"> • Basics, Types of Maintenance, Types of Replacement, • Determination of Economic Life of an Asset • Replacement of Existing Asset with a New Asset: Capital Recovery with Return, Concept of Challenger and Defender • Simple Probabilistic Model for Items Which Fail Completely. 	03
5	<p>Depreciation</p> <ul style="list-style-type: none"> • Methods of Depreciation: Straight Line Method of Depreciation, Declining Balance Method of Depreciation, Sum-of-the-Years-Digits Method of Depreciation, Sinking Fund Method of Depreciation, Service Output Method of Depreciation. <p>Evaluation of Public Alternatives</p>	03 02
6	<p>Inventory Control</p> <ul style="list-style-type: none"> • Basics, Purchase Model with Instantaneous Replenishment and without Shortages, • Manufacturing Model without Shortages • Purchase Model with Shortages (Instantaneous Supply) • Manufacturing Model with Shortages 	04
7	<p>Make or Buy Decision</p> <ul style="list-style-type: none"> • Basics, Criteria for Make or Buy • Approaches for Make or Buy Decision: Simple Cost Analysis, Economic Analysis, Break-even Analysis <p>Value Engineering</p> <ul style="list-style-type: none"> • Basics, Functions, Aim, • When to Apply Value Analysis, Value Analysis vs. Value Engineering • Value Engineering Procedure, Advantages and Application Areas <p>Mathematical Models for Value Engineering</p>	02 02 01

Text Books/ Reference Books:

1. Engineering Economy, DeGarmo, E. Paul, Sullivan and Canada, Collier MacMilan Ltd., USA
2. Engineering Economy, Gerald J. Thuesen, W. J. Fabrycky, 8th Edition, Prentice Hall International Series in Industrial and Systems Engineering
3. Engineering Economics, R. Paneerselvam, PHI Learning Pvt. Ltd. New Delhi.
4. Engineering Economic Analysis, Donald G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, Oxford University Press, 12th Edition
5. Basics of Engineering Economy, Leland Blank, Anthony Tarquin, Irwin Industrial Engineering.
6. Contemporary Engineering Economics, Chan S. Park, Pearson Pub., 5th Ed.

Sr. No.	Examination	Modules
1	Test 1	1, 2, Part of 3
2	Test 2	Part of 3, 4, Part of 5
3	End Semester	01-07

OE-BTE704 Internet of Things**Course pre-requisites: General Engineering****Course Objectives:**

1. Students will understand the concepts of Internet of Things and can able to build IoT applications.
2. Explored to the interconnection and integration of the physical world and the cyber space.
3. They are also able to design & develop IOT Devices.

Course Outcomes: Students will demonstrate the ability to

1. Understand the concepts of Internet of Things.
2. Analyze basic protocols in wireless sensor network.
3. Design IoT applications in different domain and be able to analyze their performance.
4. Implement basic IoT applications on embedded platform.

Course Contents:

Module	Details	Hours
1	Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs.	06
2	IoT & M2M: Machine to Machine, Difference between IoT and M2M, Software define Network.	06
3	Network & Communication aspects: Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.	06
4	Resource Management: Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results.	06
5	Challenges in IoT: Design challenges, Development challenges, Security challenges, Other challenges.	06
6	Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT applications.	06
7	Developing IoTs: Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.	06

Text/Reference Books:

1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011.
2. Charalampos Doukas , “Building Internet of Things with the Arduino”, Create space, April 2002.
3. Vijay Madiseti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach” .
4. Waltenequs Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice".

Sr. No.	Examination	Modules
1	Test 1	1, 2
2	Test 2	3, 4
3	End Semester	01-07

OE-BTE801 Robotics

Course pre-requisites: General Engineering

Course Objectives:

1. This course familiarizes students with the concepts and techniques in robot manipulator control.
2. Its main objective is to make students familiar with the Kinematics and Dynamics involved in robotic manipulator used in automation industry.
3. To study and appreciate the need of control theory to control such a complex nonlinear.

Course Outcomes:

1. Able to appreciate the importance of robotic arm and its applications in automation industry.
2. Able to appreciate the importance of control system theory to control such a complex nonlinear robotic arm.
3. Able to describe the kinematic and dynamic model of robotic arm.
4. Able to appreciate the importance of path, task and trajectory planning

Course Contents:

Module	Details	Hours
1	Introduction to Robotics Automation and Robots, Classification, Application, Specification, Notations.	06
2	Direct Kinematics Dot and Cross Products, Co-ordinate frames, Rotations, Homogeneous Co-ordinates, Link Coordinates, Arm Equation (Three axis, Four axis and Five axis robots).	06
3	Inverse Kinematics General properties of solutions, Tool configuration, Inverse Kinematics of Three axis, Four axis and Five axis robots.	06
4	Workspace Analysis Workspace analysis of four axis and Five axis robots, Work envelope, Workspace fixtures	06
5	Trajectory Planning Trajectory Planning, Pick and Place operations, Continuous path motion, Interpolated motion, Straight-Line motion.	06
6	Task Planning Task level programming, Uncertainty, Configuration space, Gross motion Planning, Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation	06
7	Robot Arm Dynamics Lagrange-Euler Formulation, Newton-Euler Formulation, Computational Algorithm, A two Link Manipulator Example, control Techniques applied to Robotic Arm.	06

Text/ Reference Books:

1. Robert Shilling, Fundamentals of Robotics-Analysis and Control, Prentice Hall of India.
2. Fu, Gonzales and Lee, Robotics, McGraw Hill.
3. J.J. Craig, Introduction to Robotics, Pearson Education.
4. Curtis D. Johnson, Process Control Instrumentation Technology, PHI publication.

Sr. No.	Examination	Modules
1	Test 1	1,2
2	Test 2	3,4
3	End Semester	01-07

OE-BTE802 Power Plant Engineering**Course pre-requisites: General Engineering****Course Objectives:**

To provide an overview of power plants and the associated energy conversion issues

Course Outcomes: Students will demonstrate the ability to

Understand the principles of operation for different power plants and their economics

Course Contents:

Module	Details	Hours
1	Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates	06
2	Subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems	06
3	Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) Systems	06
4	Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.	06
5	Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems	06
6	Energy, economic issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies	06
7	Energy environmental issues including waste disposal options for coal and nuclear plants.	06

Text/ Reference Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Sr. No.	Examination	Modules
1	Test 1	1, 2
2	Test 2	3, 4
3	End Semester	01-07

OE-BTE805 Image Processing**Prerequisite: Course Digital Signal Processing****Course Objectives:**

1. To develop an overview of the field of image processing
2. To learn the fundamental concepts of Digital Image Processing
3. To understand basic image enhancement and segmentation techniques
4. To illustrate Image Transform calculations mathematically and develop fast transform algorithm
5. To learn Image Compression and Decompression Techniques

Course Outcomes: Students will demonstrate the ability to

1. Understand the concept of Digital Image processing.
2. Explain image enhancement and Segmentation technique
3. Understand Digital Image compression and decompression techniques
4. Perform Binary Image Processing

Course Contents:

Module	Details	Hours
1	Introduction: Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	04
2	Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imaging Geometry. Image File Formats: BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV)	06
3	Image Enhancement: Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background Smoothing Filters, Sharpening Filters, Low pass Filtering, High pass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. Homomorphic Filtering	08
4	Image Segmentation and Representation: (i) Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique, (ii) Image Representation and Description, Chain Code, Polygonal, Representation, Shape Number, Moments	06
5	Binary Image Processing: Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening,	06

	Connected Component Labeling, Iterative Algorithm and Classical Algorithm	
6	Image Transform: (i) Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform Fast Fourier Transform(FFT), (ii) Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	06
7	Image Compression: Fundamentals – Coding Redundancy, Interpixel Redundancy, Psycho visual Redundancy, Fidelity Criteria. Image Compression Models – The Source Encoder and Decoder, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	06

Text/ Reference Books:

1. Rafael C. Gonzalez and Richard E. Woods, „Digital Image Processing“, Pearson Education Asia, Third Edition, 2009,
2. S. Jayaraman, E. Esakkirajan and T. Veerkumar, “Digital Image Processing” Tata McGraw Hill Education Private Ltd, 2009,
3. Anil K. Jain, “Fundamentals and Digital Image Processing”, Prentice Hall of India Private Ltd, Third Edition

Sr. No.	Examination	Modules
1	Test 1	1, 2, Part of 3
2	Test 2	Part of 3, 4, Part of 5
3	End Semester	01-07