SYLLABUS FOR B.E. VII & VIII SEMESTER

(With effect from 2015- 16 Academic year)

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2015–16)

BACHELOR DEGREE

IN

DEPARTMENT OF MECHANICAL ENGINEERING

OUT COME BASED EDUCATION

P.E.S. COLLEGE OF ENGINEERING,

MANDYA - 571 401, KARNATAKA

(An Autonomous Institution Affiliated to VTU, Belagavi)

Grant -in- Aid Institution (Government of Karnataka)

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ

(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

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PREFACE

PES College of Engineering, Mandya, started in the year 1962, has become autonomous institute in the academic year 2008-09. Since, then it has been doing the academics and assessment activities successfully. The college is running eight undergraduate and eight Postgraduate programs including MBA and MCA which are affiliated to VTU, Belagavi.

India has recently become a Permanent Member of the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations. The implementation of Outcome Based Education (OBE) has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the various countries.

Our Higher Educational Institution has adopted the Choice Based Credit System (CBCS) based semester structure with OBE scheme and grading system. Which provides the flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. There lies a shift in thinking, teaching and learning process moving towards Students Centric from Teachers Centric education which enhances the knowledge, skills & moral values of each student.

Choice Based Credit System (CBCS) provides the options for the students to select from the number of prescribed courses. The CBCS provides a 'cafeteria' type approach in which the students can Choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach for learning which enables integration of concepts, theories, techniques. These are greatly enhances the skill/employability of students.

In order to increase the Industry/Corporate readiness, many Soft Skills, self learning components and Personality Development modules have been added to the existing curriculum. In order to enhance creativity and innovation Mini Project and Industrial visit & Interaction are made mandatory for all undergraduate programs.

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Associate Professor,
Dept. of Computer Science & Engg.

Dr. P S Puttaswamy
Dean (Academic)
Professor
Dept. of Electrical & Electronics Engg.

PES College of Engineering, Mandya

College Vision

"*A* leading institution imparting quality engineering and management education developing creative and socially responsible professionals"

College Mission

Mission of P E S College of Engineering is to,

- Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.
- Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.
- Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.
- Promote research, product development and industry-institution interaction.

About the Department of Mechanical Engineering

The department of Mechanical Engineering was established in the year 1962 during the origination of the institute. The department was granted academic autonomy in the year 2009.
The department presently offers B.E in Mechanical Engineering, M Tech in Computer Integrated Manufacturing (CIM), M Tech in Machine Design, M.Sc., (Engg.) by research and research leading to Ph.D. The present intake capacity of the department is 120 for BE, 18 for M Tech CIM and 24 for M Tech Machine Design. The department has a faculty-student ratio of 1:15 for UG courses and 1:12 for PG courses. The department has well established laboratories to meet the academic requirements of UG and PG programmes and a skilled technical faculty to train the students. The department has its own library which has a collection of about 3861 reference books.
The department has been NBA accreditated for 3Years in 2017.
The department regularly organizes industrial visits, technical lectures by experts from industries and institutes in contemporary areas to bridge the gap between syllabi and current developments. The students are encouraged to undergo industrial training as well as to take up industry oriented projects during their academic course. Mechanical Engineering Association, formed by the students and faculty of the department regularly organizes cocurricular and extracurricular activities for the students.

Department Vision

"Be a department well recognized for its ability to develop competent mechanical engineers capable of working in global environment"

Department Mission

The Mission of the Department of Mechanical Engineering is to:

- Provide quality education by competent faculty.
- Provide adequate infrastructure and learning ambience for the development of essential technical skills.
- Inculcate a sense of higher education and research orientation.
- Foster industry interaction.

Program Educational Objectives (PEOs)

The Department of Mechanical Engineering has formulated the following programme educational objectives for the under-graduate program in Mechanical Engineering:
The Mechanical Engineering graduates will be able to:

PEO1: Use the fundamentals of basic science, mathematics and mechanical engineering, to pursue their career as engineers as well as to lead and manage teams in global organizations.

PEO2: Pursue advanced education, research and development and engage in the process of life-long learning.

PEO3: Become entrepreneurs in a responsible, professional and ethical manner to serve the

society.

Program Specific Outcomes (PSOs)

Engineering graduates should be able to:

PSO1: Apply computer simulation and experimental methods in the design and development of sustainable products of mechanical systems.

PSO2: Utilizethe knowledge of advanced manufacturing and condition monitoring techniques in industrial applications.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PES COLLEGE OF ENGINEERING, MANDYA

(An Autonomous Institution, Under VTU)

Scheme of Teaching and Examination **VII Semester B.E. (ME)**

Sl. No.	Course Code	Course Title	Teaching Dept.	Hrs/Week L:T:P:H	Total Credit	Examination Marks		
						CIE	SEE	Total
1.	P15ME71	Core Course I **Automatic Control Engineering**	Mechanical	3:2:0:5	4	50	50	100
2.	P15ME72	Core Course II **Management & Entrepreneurship**	Mechanical	4:0:0:4	4	50	50	100
3.	P15ME73	Core Course III **Production Management**	Mechanical	4:0:0:4	4	50	50	100
4.	P15ME74#	Elective-IV	Mechanical	4:0:0:4	3	50	50	100
5.	P15ME75#	Open Elective-I	Mechanical	4:0:0:4	3	50	50	100
6.	P15MEL76	Laboratory I **Design Lab**	Mechanical	0:0:3:3	1.5	50	50	100
7.	P15MEL77	Laboratory II **Simulations Lab**	Mechanical	0:0:3:3	1.5	50	50	100
8.	P15ME78	Project Work Phase - I	Mechanical	0:0:4:2	2	--	50	50
				Total	23	350	400	750

List of Electives

Elective - IV				**Open Elective - I**	
Sl. No.	Course Code	Course title	Sl. No.	Course Code	Course title
1.	P15ME741	Industrial Automation	1.	P15ME751	Total Quality Management
2.	P15ME742	Hydraulics & Pneumatics	2.	P15ME752	Operations Research
3.	P15ME743	Theory of Plasticity	3.	P15ME753	Renewable Energy Technology
4.	P15ME744	Gas Turbines	4.	P15ME754	Finite Element Method in Engineering

Scheme of Teaching and Examination **VIII Semester B.E. (ME)**

Sl. No.	Course Code	Course Title	Teaching Dept.	Hrs/ Week L:T:P:H	Total Credit	Examination Marks		
						CIE	SEE	Total
1.	P15ME81	Core Course I **Industrial Robotics**	Mechanical	4:0:0:4	3	50	50	100
2.	P15ME82#	Elective-V	Mechanical	4:0:0:4	3	50	50	100
3.	P15ME83#	Elective-VI	Mechanical	4:0:0:4	3	50	50	100
4.	P15ME84#	Open Elective-II	Mechanical	4:0:0:4	3	50	50	100
5.	P15ME85	Project Work Phase - II	Mechanical	0:0:16:16	8	50	100	150
6.	P15ME86	Internship	Mechanical	0:0:2:2	2	50	--	50
Total					22	300	300	600

List of Electives

Elective - V			**Elective - VI**			**Open Elective - II**		
Sl. No.	Course Code	Course title	Sl. No.	Course Code	Course title	Sl. No.	Course Code	Course title
1.	P15ME821	Operations Research	1.	P15ME831	Project Management	1.	P15ME841	Industrial Robotics & Automation
2.	P15ME822	Foundry &Welding Technology	2.	P15ME832	Additive Manufacturing Techniques	2.	P15ME842	Additive Manufacturing Techniques
3.	P15ME823	Renewable Energy Technology	3.	P15ME833	Power Plant Engineering	3.	P15ME843	Power Plant Engineering
4.	P15ME824	Computational Fluid Dynamics	4.	P15ME834	Tribology	4.	P15ME844	Maintenance Engineering

Semester:-VII

Course Title: Automatic Control Engineering			
Course Code: **P15ME71**	Semester: VII	L-T-P-H: 3-2-0-5	Credits: 04
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at strengthening the ability of students in design and analysis of linear continues-time control systems to improve their static and transient behavior.

Course Content

UNIT-I

Introduction and Mathematical Models of Physical Systems: Concept of automatic controls, open and closed loop control systems, concepts of feedback control systems, requirement of an ideal control system. Examples of control systems - Speed control system, Human body temperature control system, Home heating system, Traffic control system, Liquid level control system. Definition of Laplace transformation, Transfer function models, mathematical models of mechanical systems, models of electrical circuits, models of DC and AC motors, models of hydraulic systems and models of thermal systems. Analogous Systems- Force-voltage analogy and force-current analogy. **10 Hrs**

UNIT-II

Block Diagrams & Signal Flow Graphs and Time Response Analysis: Transfer functions definition, block representation of system elements, reduction of block diagrams with single and multiple inputs. Signal flow graphs- Signal flow graph terminology, signal flow graph from block diagram, Manson's gain formula. **10 Hrs**

UNIT-III

Time Response Analyses: Time response analysis - Introduction, transient and steady state response of control system, standard test inputs – step, ramp, parabolic and impulse inputs. First order system response to step and ramp inputs, concepts of time constant and its importance in speed of response. Second order system response to step input, transient response specifications. Steady-state error analysis- control system type, steady-state error constants- static position error constant, static velocity error constant and static acceleration error. Stability definition, mathematical concept of stability, characteristic root locations and stability, Routh's stability criterion, special cases of Routh's criterion. **10 Hrs**

UNIT-IV

Frequency Response Analysis: Polar plots, relative stability- concepts phase margin and gain margin. Nyquist Stability Criterion, Stability analysis using Nyquist plot. Frequency response analysis using bode plot: Bode attenuation diagrams, stability analysis using Bode plots. **12 Hrs**

UNIT-V

Root Locus and State-Space Analyses: Root locus analysis- Introduction, definition of root loci, general rules for constructing root loci, root locus analysis of control systems. State-space analysis- introduction, definitions, state-space equations, transformation matrix, controllability and observability. **10 Hrs**

Text Books

1. Katsuhiko Ogata, **Modern Control Engineering,** Phi Learning Pvt Ltd, 5th Edition, 2010, ISBN: 9788120340107.
2. Rao V Dukkipati, **Control Systems,** Narosa Publishing House, 2008, ISBN: 978-8173195549.
3. Joseph J. Distefano, Allen R. Stubberud and Avan J. Williams, **Feedback and Control Systems**, Schaum's Outlines series, Tata McGraw Hill, New Delhi, 2nd Edition, 2003, ISBN: 978-0070582880.

Reference Books

1. I. J. Nagarath & M. Gopal, Control systems, New age International publishers, 4th Edition, 2006, ISBN: 978-8122417753.

2. F. Golnaraghi and B.C. Kuo, Automatic Control Systems, John Wiley & Sons, 9th Edition, 2009, ISBN: 978-0470048962.
3. Control Systems: Ashfaq Husain and Haroon Ashfaq, Dhanpat Rai & Co., 2015, ISBN: 978-8177000276.

Course Outcomes

After learning all the units of the course, the student is able to;

1. Identify and classify the different types of control systems. Develop mathematical model for the mechanical, electrical, servo mechanism and hydraulic systems.
2. Represent the systems consisting of number of components in the form of block diagrams and signal flow graphs and Develop mathematical models using reduction technique of these block diagrams and signal flow graphs.
3. Obtain the time response and steady-state error of the system. Determine stability of the various control systems by applying Routh's stability criterion.
4. Obtain frequency response and Determine stability of control system applying Nyquist stability criterion and using Bode plot.
5. Construct root loci from open loop transfer functions of control systems and Analyze the behavior of roots with system gain. Analyze complex systems having multi inputs and multi outputs using state-space method

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** and **classify** the different types of control systems. **Develop** mathematical model for the mechanical, electrical, servo mechanism and hydraulic systems.	**3**	**3**	**2**	**1**								**1**	**1**	
CO2	**Represent** the systems consisting of number of components in the form of block diagrams and signal flow graphs and **Develop** mathematical models using reduction technique of these block diagrams and signal flow graphs.	**3**	**3**	**2**		**1**							**2**	**1**	**1**
CO3	**Obtain** the time response and steady-state error of the system**. Determine** stability of the various control systems by **applying** Routh's stability criterion.	**3**	**3**	**3**	**2**	**2**							**2**	**2**	**1**
CO4	**Obtain** frequency response and **Determine** stability of control system by **applying** Nyquist stability criterion and **using** Bode plot.	**3**	**3**	**3**	**2**	**3**		**2**					**2**	**2**	
CO5	**Construct** root loci from open loop transfer functions of control systems and **Analyze** the behavior of roots with system gain. **Analyze** complex systems having multi inputs and multi outputs using state-space method.	**3**	**3**	**3**	**2**	**3**		**1**					**2**	**1**	

Course Title: Management and Entrepreneurship			
Course Code: **P15ME72**	Semester: VII	L-T-P-H: 4-0-0-0	Credits: 04
Contact Period - Lecture: 52 Hrs.; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at enabling the students to understand the basic concepts of Management, Principles of organization, organization theories, evolution of entrepreneur concept, Types and functions of entrepreneur, characteristics, importance of motivation and its kinds, project identification, preparation, selection and reporting.

Course Content

UNIT-I

MANAGEMENT: Introduction, meaning, nature and characteristics of management, scope and functional area of management, management as a science, art or profession, management & administration, role of management, levels of management, development of management thought, early and modern management approaches. **10 Hrs**

UNIT-II

ORGANIZATION STRUCTURE: Principles of organization, organization theories, departmentation, authority, power, organizing, organizational effectiveness, structuring the organization, organizational change, organization charts, types of organizations, Span of control, forms and functions of committees. **10 Hrs**

UNIT-III

ENTREPRENEURSHIP: meaning of entrepreneur, evolution of concept, functions of entrepreneur, types of entrepreneur, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, entrepreneurship and its barriers. **10 Hrs**

UNIT-IV

MOTIVATION, JOB ANALYSIS, JOB EVALUATION, WAGES & INCENTIVES: Introduction, characteristics, importance, kinds of motivation. Thoughts of motivation philosophy: Maslow's theory of needs, Gouglass Mc Gregore – 'X' & ' Y' theory, Herzberg's theory, Incentives as motivators, managing dissatisfaction and frustration. Job analysis, job description, job specification, job design: job evaluation, time recording, wage and incentives. Wages, methods of wage payment, incentives. Bonus system. Non financial incentives. Time rate v/s piece rate, fringe benefits, numericals. **12 Hrs**

UNIT-V

PROJECTOLOGY AND SMALL SCALE INDUSTRIES (SSI): Meaning of a project, project identification, project preparation, project selection, project report, need and significance of a project report, contents, project planning, project monitoring and control, project evaluation, errors of a project report, project appraisal, project cycle and project phases. Identification of business opportunities: market, technical, financial and social feasibility study. Steps to start SSI, Government support to SSI. **10 Hrs**

Text Books

1. Principles of management, P C Tripathi, P N Reddy, Tata McGraw Hill.
2. Dynamics of Entrepreneurial Development & Management, Vasanth, Desai, Himalaya Publishing House
3. Entrepreneurship Development, Small business enterprise, Poornima M , Charanthi math, Pearson Education 2005(2&4)

Reference Books

1. Management Fundamentals Concepts, Application& skill development By Robert lusier, Thomson
2. Management By Stephen Robbins, Pearson Education/PHI 17th Edition, 2003
3. Entrepreneurship Development, By SS Khanka, S Chand& Co

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Identify** the nature and characteristics of management, scope and functional area of management.
2. **Discuss** the Principles of organization, organization theories, departmentation, authority, power, organizing, organizational effectiveness, Span of control.
3. **Analyses** the stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, entrepreneurship and its barriers.
4. **Analyze** the Job, job description, job specification, job design: job evaluation, time recording, wage and incentives. Wages, methods of wage payment, incentives. Bonus system. Non-financial incentives. Time rate v/s piece rate, fringe benefits.
5. **Generate** project identification, project preparation, project selection, project report, need and significance of a project report, contents, project planning, project monitoring and control, project evaluation, errors of a project report.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** nature and characteristics of management, scope and functional area of management	**2**	**2**	**1**									**1**	-	-
CO2	**Understand** Principles of organization, organization theories, departmentation, authority, power, organizing, organizational effectiveness.	**2**	**2**										**1**	-	-
CO3	**Analyses** stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, entrepreneurship-its barriers	**2**	**2**										**1**	-	-
CO4	**Evaluate** Job analysis, job description, job specification, job design: job evaluation, time recording, wage and incentives. Wages, methods of wage payment, incentives. Bonus system. Non-financial incentives. Time rate v/s piece rate, fringe benefits	**2**	**2**	**1**									**1**	-	-
CO5	**Generate** project identification, project preparation, project selection, project report, need and significance of a project report, contents, project planning, project monitoring and control, project evaluation, errors of a project report	**2**	**2**	**1**									**1**	-	-

Course Title: Production Management			
Course Code: **P15ME73**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 04
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %; SEE: 50%	

Course Objectives: The course aims at enabling the students to understand the basic concepts of production, forecasting, and various scheduling techniques related to manufacturing.

Course Content

UNIT-I

Introduction: Introduction, meaning and concepts of production management, area of production management, relationship of PM, tools and techniques of PM, evolution of PM, PM, a system view point, PM today, productivity improvement, future of PM. product strategies, the product life cycle, productive system types, process focussed system, product focussed system, production to stock or order, productive system positioning strategies, process line technology, interdependent product lines, organization of the operations functions-process focussed organisation, product focussed organisation structure, difference between process and product focused. **10 Hrs**

UNIT-II

Forecasting: Types and uses of forecasting, moving average, Exponentially weighed moving averages. Trend model with seasonal variation. Delphi technique. **11Hrs**

UNIT-III

Facilities Location and Layout: Introduction, general procedure for location, factors affecting location, locational analysis- cost analysis, quantitative method, weight method, GRID method, objectives of plant layout, factors affecting plant layout, material flow pattern, layout. **10 Hrs**

UNIT-IV

Scheduling: Master scheduling, scheduling sequence operation standard scheduling techniques. Johnson s rule for 2 machines, 3 machines, and n machines. Graphical method for 2 machines and n jobs. **11Hrs**

UNIT-V

Machine Loading Techniques: Indexing method, machine loading and follow up by use of Gantt Charts, Schedule boards and other commercial techniques.

Production Control: Despatching and Expediting the orders. Centralized and Decentralized dispatching process order control. Follow up and progress reporting, rescheduling and priority rules. **10 Hrs**

Text Books

1. Buffa and Sarin, Modern Production/Operations Management, Wiley India Pvt. Ltd.-New Delhi, 8th Edition , 23 August 2007, 9788126513727
2. Samuel Eilon, Elements of Production Planning and Control, Universal Publishing Corporation, 1991, ISBN: 9788185027098
3. S.K.Hajra Choudhury, Nirjhar Roy, A.K. Hajra Choudhury, Production Management, Media Promotors & Pub. Pvt. Ltd., 1998, ISBN: 978-8185099255.
4. Joseph G.Monks, Operations Management, Tata McGRAW-Hill New Delhi, 2004.

Reference Books

1. Barry Shore, Operations Management, McGraw-Hill Inc., USA, 1st January 1973, ISBN: 9780070570450
2. R. Panneerselvam, Production and Operations Management, PHI Publishers , 3rd Edition,2006, ISBN: 9788120345553

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Define** Production management, product life cycle, process focussed system, product focussed system
2. **Analyze** Productive system types, organization of the operations functions-process focussed organisation, product focussed organisation structure
3. **Describe** cost analysis.
4. **Compare** Types of forecasting moving average Exponentially weighed moving averages. Trend model with seasonal variation. Delphi technique.
5. **Discuss** Scheduling, standard scheduling techniques. Machine loading and follow up by use of Gantt Charts. Despatching and Expediting.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Define:** Production management, product life cycle, process focussed system, product focussed system	**1**												-	-
CO2	**Analyze:** Productive system types, organization of the operations functions-process focussed organisation, product focussed organisation structure	**1**		**2**										-	-
CO3	**Describe:** cost analysis.					**3**							**1**	-	**1**
CO4	**Compare:** Types of forecasting moving average Exponentially weighed moving averages. Trend model with seasonal variation. Delphi technique..					**3**							**1**	-	-
CO5	**Discuss:** Scheduling, standard scheduling techniques. Machine loading and follow up by use of Gantt Charts. Despatching and Expediting					**2**							**2**	-	-

Course Title: Industrial Automation			
Course Code: **P15ME741**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at enabling the students to understand the Industrial automation and Quality control systems.

Course Content

UNIT-I

INTRODUCTION: Production System Facilities, Manufacturing Support systems, Automation in Production systems, Automation principles & Strategies**.**

AUTOMATION: Basic Elements of an Automated System, Advanced Automation Functions & Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control. **10 Hrs**

UNIT-II

HARDWARE COMPONENTS FOR AUTOMATION AND PROCESS CONTROL: Sensors, Actuators, Analog-to-Digital Converters, Digital-to-Analog Converters, Input/Output Devices for Discrete Data

AUTOMATED MANUFACTURING SYSTEMS: Components of Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells. **12 Hrs**

UNIT-III

CELLULAR MANUFACTURING: Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, Application of group technology,

FLEXIBLE MANUFACTURING SYSTEMS: Introduction to FMS, FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues. **10 Hrs**

UNIT-IV

INSPECTION TECHNOLOGIES: Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, optical Inspection Techniques & Non-contact Non optical Inspection Technologies. **10 Hrs**

UNIT-V

MANUFACTURING SUPPORT SYSTEM: Process Planning, Computer Aided Process Planning, Concurrent Engineering & Design for Manufacturing, Advanced Manufacturing Planning, lean production and waste in manufacturing, Just-in Time Production System, Automation, Worker involvement, Basic concepts of lean and Agile manufacturing, Comparisons of Lean & Agile Manufacturing. **10 Hrs**

Text Books

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson education. 3rd Edition, 2008, ISBN: 9788120334182
2. Vajpayee, and S. Kant, **Principle of Computer-Integrated Manufacturing,** PHI, 1st Edition, 1998, ISBN: 978-8120314764.

Reference Books

1. Amber G.H & P. S. Amber, Anatomy of Automation, Literary Licensing ,LLC 2012, ISBN: 9781258304256
2. Viswanandham, Performance Modeling of Automated Manufacturing Systems, PHI, 1st Edition, 2008, ISBN: 9788120308701
3. Krishna Kant, Computer Based Industrial Control, EEE-PHI **,** 1st Edition, 15 August 2004, ISBN: 9788120311237

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Identify:** Production System Facilities, Manufacturing Support systems, Automation in Production systems, Basic Elements of an Automated System, Forms of Computer

Process Control

2. **Analyze:** Sensors, Actuators, Analog-to-Digital Converters, Digital-to-Analog Converters, Single Station Manned Workstations and Single Station Automated Cells.
3. **Describe:** Production Flow Analysis, Cellular Manufacturing, Application of group technology and FMS Planning & Implementation Issues.
4. **Explain:** Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering, Automated Inspection, Coordinate Measuring Machines Construction, Inspection Probes on Machine Tools, Machine Vision, and Optical Inspection Techniques.
5. **Discuss:** Process Planning, Computer Aided Process Planning, Concurrent Engineering & Design for Manufacturing, JIT production system, Basic concepts of lean and Agile manufacturing.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify:** Production System Facilities, Manufacturing Support systems, Automation in Production systems, Basic Elements of an Automated System, Forms of Computer Process Control		**1**			**2**				**1**				-	-
CO2	**Analyze:** Sensors, Actuators, Analog-to-Digital Converters, Digital-to-Analog Converters, Single Station Manned Workstations and Single Station Automated Cells.	**2**	**1**	**1**		**2**				**2**				-	-
CO3	**Describe:** Production Flow Analysis, Cellular Manufacturing, Application of group technology and FMS Planning & Implementation Issues.		**1**	**2**		**1**								-	-
CO4	**Explain:** Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering, Automated Inspection, Coordinate Measuring Machines Construction, Inspection Probes on Machine Tools, Machine Vision, and Optical Inspection Techniques.	**2**	**2**	**1**						**2**				-	-
CO5	**Discuss:** Process Planning, Computer Aided Process Planning, Concurrent Engineering & Design for Manufacturing, JIT production system, Basic concepts of lean and Agile manufacturing.		**1**	**1**		**2**				**1**				-	-

Course Title: Hydraulics and Pneumatics			
Course Code: **P15ME742**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs.; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at understanding and strengthening knowledge of the Hydraulic and Pneumatic basics, circuit diagram and circuit symbol, actuators, motors, valves and maintenance of hydraulic systems to students by exposing them to understand for different machines that are commonly used in industries.

Course Content

UNIT-I

INTRODUCTION TO HYDRAULIC POWER: Pascal's law and problems on Pascal's law. Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps, Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps and Numericals.

HYDRAULIC ACTUATORS AND MOTORS: Linear Hydraulic Actuators [cylinders], Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance. **10 Hrs**

UNIT-II

CONTROL COMPONENTS IN HYDRAULIC SYSTEMS: Directional Control Valves Symbolic representation, Constructional features, pressure control valves, direct and pilot operated types, flow control valves.

HYDRAULIC CIRCUIT DESIGN AND ANALYSIS: Control of single and double acting Hydraulic cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application. Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits. **10Hrs**

UNIT-III

MAINTENANCE OF HYDRAULIC SYSTEMS: Hydraulic oils Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, troubleshooting.

INTRODUCTION TO PNEUMATIC CONTROL: Choice of working medium,

Characteristics of compressed air. Structure of Pneumatic control system cylinder working end position cushioning, seals, mounting arrangements. Rod less cylinders types, working advantages. Rotary cylinder types construction and application. Design parameters selection. **11 Hrs**

UNIT-IV

DIRECTIONAL CONTROL VALVES: Symbolic representation as per ISO1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve. **10 Hrs**

UNIT-V

MULTI-CYLINDER APPLICATIONS: Coordinated and sequential motion control. Motion and control diagrams Signal elimination methods. Cascading method principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves).Compressed air: Production of compressed air compressors, preparation of compressed air-Driers, Filters, Regulators. Lubricators, Distribution of compressed air-Piping layout. **11 Hrs**

Text Books

1. Anthony Esposito Fluid Power with applications:, 5th edition pearson education, Inc. 2000, ISBN: 9780130102256

2. Andrew Parr Pneumatics and Hydraulics: Jaico Publishing Co. 1st Edition, 2000, ISBN: 9788172241896

Reference Books

1. S.R Majumdar Oil Hydraulic Systems Principles and Maintenance: 2002, Tata McGraw Hill publishing company Ltd. 2001, ISBN: 9780071406697
2. S.R.Majumdar Pneumatic systems by, Tata McGraw Hill publishing Co, 1995, ISBN: 9780071359658
3. Pippenger Hicks Industrial Hydraulics: McGraw Hill, New York, 2nd Edition, 1980, ISBN: 9780070664777
4. Dr. H D Ramachandra Hydraulics and Pneumatics Sudha Publications-2013

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Derive** Pascal's law. **Explain** Linear Hydraulic Actuators [cylinders], Hydraulic Rotary Actuators and hydraulic motor performance.
2. **Explain** Cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits **Discuss**: Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve
3. **Explain** Hydraulic oils Desirable properties, general type of fluids, sealing devices, reservoir system. **Describe** the choice of working medium, characteristics of compressed air. Structure of Pneumatic control system cylinder working end position cushioning, seals, mounting arrangements applications.
4. **Explain**: poppet valves, slide valves spool valve, suspended seat type slide valve. **Describe**: Direct and indirect actuation of pneumatic cylinders, Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve.

   Describe Cascading method principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves). Production of compressed air compressors, preparation of compressed air-Driers, Filters, Regulators. Lubricators, Distribution of compressed air-Piping layout.

Course Articulation Matrix

Course Outcomes	Program Outcomes												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**2**			**1**						**2**			**-**	**-**
CO2	**1**		**3**				**2**						**-**	**1**
CO3			**1**		**3**				**2**				**-**	**1**
CO4		**1**				**3**		**2**					**-**	**1**
CO5	**1**			**3**							**2**		**-**	**1**

Course Title: Theory of Plasticity			
Course Code: **P15ME743**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %; SEE: 50%	

Course Objectives: To provide a basic understanding of the plasticity theory as applied to metalworking processes and their analysis for improved quality and productivity.

Course Content

UNIT-I

Fundamental of elasticity: Concept of stress, Equilibrium equation stress transformation laws, spherical and deviator stress tensors, octahedral stresses. Concept of strain, representation strain, compatibility equations, deviator and spherical strain tensors, strain transformation laws, octahedral strains, elastic strain energy, theories of strength, Numerical. **10 Hrs**

UNIT-II

Plastic deformation of metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures (Luder's lines).

Yield Criteria: Introduction, yield or plasticity conditions Tresca and Von-Mises criteria, experimental evidence for yield criteria (a) Lode's experiment (b) Quinney's experiment. The Haigh-Westergaard stress space. Traces of the yield surfaces in 2D stress space. **10 Hrs**

UNIT-III

Stress- Strain relations: Introduction, types of materials, empirical equations, theories of plastic flow, experimental verification of St Venant's theory of plastic flow, the concept of plastic potential, the maximum work hypothesis. **10 Hrs**

UNIT-IV

Slip Line Field Theory: Introduction, basic equations for incompressible two dimensional flow, continuity equations(Geiringer equation), stresses in conditions of plain strain, convention for slip lines, solutions of plastic deformation problem, geometry of slip line filed, properties of slip lines, construction of slip line nets. **10 Hrs**

UNIT-V

Bending of Beams: Introduction, analysis of stresses, Non-linear stress-strain curve, shear stress distribution, Residual stresses in plastic bending, Numerical.

Torsion of bars: Introduction, plastic torsion of a circular bar, Elastic- perfectly - plastic material, Elastic work hardening material, Residual stresses and Numerical. **12Hrs**

Text Books

1. Sadhu Singh, Theory of Plasticity & Metal Forming Processes, Khanna Publishers, 3rd Edition ,2015, ISBN: 9788174090509
2. R. A. W. Slater, Engineering Plasticity: Theory and Application to Metal Forming Processes , McMillan Press Ltd, 1st Edition, 1977, ISBN: 9780333157091

Reference Books

1. J. Chakraborty, Theory of plasticity, Butter-Heinemann publisher, 3rd Edition, 20 August 2007, ISBN: 9789380931715
2. Jacob Lubliner, Plasticity Theory **,** Dover publications Inc, 1st Edition, 2008, ISBN:9780486462905
3. Avitzur, B., Metal Forming Processes and Analysis, McGraw-Hill, 1st Edition,1968 , ISBN : 9780070025103
4. L. M. Kachanov**,** Fundamentals of the Theory of Plasticity , Dover Publication,1st Edition,2004 **,** ISBN: 9780486435831

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Derive** the equation for stress transformation, spherical, deviator, octahedral stresses and

strains, and **calculate** the same.

2. **Explain** factors affecting plastic deformation, strain hardening, recovery, recrystallization, cubical dilation, and true stress and strain. **Calculate** Yield stress
3. **Explain** St Venant's theory of plastic flow.
4. **Derive** basic equation for incompressible two dimensional flows, continuity equation and **explain** geometry of slip line field, properties of the slip lines.
5. **Explain** non linear stress strain curve, shear stress distribution, residual stresses in plastic bending, and plastic torsion of circular bar and **calculate** residual stresses.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Derive** the equation for stress transformation, spherical, deviator, octahedral stresses and strains, and **calculate** the same.	**3**	**2**											**1**	**-**
CO2	**Explain** factors affecting plastic deformation, strain hardening, recovery, recrystallization, cubical dilation, and true stress and strain. **Calculate** Yield stress.	**3**	**2**			**1**								**2**	**-**
CO3	**Explain** St Venant's theory of plastic flow.	**3**	**2**	**1**									**1**	**1**	**-**
CO4	**Derive** basic equation for incompressible two dimensional flows, continuity equation and **explain** geometry of slip line field, properties of the slip lines.	**3**	**2**	**2**	**2**	**1**							**1**	**-**	**-**
CO5	**Explain** non linear stress strain curve, shear stress distribution, residual stresses in plastic bending, and plastic torsion of circular bar and **calculate** residual stresses.	**3**	**3**	**2**	**3**	**2**				**1**			**2**	**-**	**-**

Course Title: Gas Turbines			
Course Code: **P15ME744**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The objectives of the course are to develop the students ability to understand the thermodynamics of each component, the linked system performance of all components in the Gas turbine engine and performance trends for each component which include compressors, burners, turbines regenerator.

Course Content

UNIT-I

Ideal plant cycles: Introduction, Carnot cycle, Stirling cycle with regenerator, Ericsson cycle, Joule air cycle, Brayton cycle with regenerator, complex cycles, The closed cycle, Operating media other than air,

Performance of actual gas turbine cycle: Efficiency of compressor and turbine, Pressure or flow losses, Heat exchanger effectiveness, Effect of varying mass flow, Loss due to incomplete combustion, Mechanical losses, Effect of variable specific heat, Calculation of fuel consumption and cycle efficiency, Polytropic efficiency, Performance of actual cycle, Jet propulsion, Specific thrust of the turbo-jet engine, Thermal efficiency of turbo jet engine, Propulsive efficiency, Effect of forward speed, Effect of altitude, Numerical examples.**10Hrs**

UNIT-II

Centrifugal compressors: Components, Method of operation, Theory of operation, Ideal energy transfer. Actual energy transfer- Slip, Analytical method of finding slip factor, Power input factor, Pressure coefficient, Compressor efficiency. Inlet or inducer section- when the entrance is axial, sizing of inducer section, Prewhirl. Impeller passage- Effect of impeller blade shape on performance, The impeller channel. The compressor diffuser, Losses in centrifugal compressor, Compressor characteristic, Surging and choking

Axial flow compressor: Introduction, Description, Performance analysis. Momentum or filament analysis –Spatial velocity diagram, Symmetric stage, Non-symmetric axial inflow, Non-symmetric axial out flow, Actual energy transfer. Airfoil analysis - One dimensional ideal incompressible flow, Two dimensional flow with friction. Blading efficiency – Losses in terms of air angles and drag coefficient. Coefficient of performance- flow coefficient, Pressure coefficient, Work coefficient. Blade loading, Cascade characteristic, Blade angles, Reynolds and Mach number effects. Compressor stall and surge, overall performance, Compressor characteristics. Numerical examples. **12 Hrs**

UNIT-III

Combustion systems: Introduction, Combustion mechanism, Pressure losses, Combustion intensity, Combustion efficiency, Requirement of Combustion chamber, Shape of the combustion chamber, Stabilizing or primary zone, Dilution and mixing, Combustion chamber arrangements, Fuel injection system

Regenerator: Introduction, Types of regenerator, Heat transfer in direct type exchangers- Exchanger heat transfer effectiveness, Number of exchanger heat transfer units, Capacity ratio, Relation between NTU and Stanton number, Relations between NTU and effectiveness(no derivation), Effect of flow arrangement, Effect of $C_{min}/C_{max}<1$ for regenerator, Log mean rate equation compared to effectiveness –NTU approach. Rotary heat exchanger- Effect of Matreix speed, Effect of longitudinal conduction, Core pressure drop. Some economics approach of heat exchanger design. Numerical examples. **10 Hrs**

UNIT-IV

Axial flow gas turbines: Introduction, Turbine and nozzle efficiencies. Degree of reaction- Impulse turbine, Ideal impulse turbine, Impulse turbine with loss, Blade speed ratio, Velocity ratio and torque, Velocity compounded turbine. The reaction turbine- Reheat factor, Blade speed ratio for reaction turbine. Comparison of turbine types, Forces on blade, Cascade analysis, Three dimensional flow analysis – The free vortex blades, Constant angle nozzle

stage. Turbine flow passage- Impulse blading, Reaction blading. Turbine characteristics.
10 Hrs

UNIT-V

Performance of Gas turbine power plant: Non dimensional representation of compressor and turbine performance, Performance characteristics of compressor and turbines compressors, Matching of compressor and turbine in a self driving system, Equilibrium running of simple jet and propeller turbine engines, Simple jet unit, nozzle characteristic, Effect of adding a propelling nozzle to the compressor turbine combination, Variation of thrust with forward speed and rpm, Variation of specific fuel consumption with forward speed and rpm, Discussion on the equilibrium running diagram ,Propeller turbine engines(turboprop), Combined turbines.

Environmental consideration: Air pollution, Aircraft emission standards, Stationary engine emission standards, NO_x formation, NO_x reduction in stationary engines, Noise, Noise standards, Noise reduction. **10 Hrs**

Text Books

1. P.R. Khajuria.and S. P. Dubey, Gas Turbines and Propulsive System, Dhanpat Rai Publication, 2012, ISBN: 9788189928483
2. V Ganeshan, Gas Turbines McGraw –Hill Publication, 3rd Edition, 2010, ISBN: 9780070681927

Reference Books

1. H. I. H Saravanamutto, GFC Rogers, H Cohen, Gas Turbine Theory, Pearson Education, 5th Edition, 2001, ISBN: 9788178085340
2. Turbines Compressor and Fans, S. M. Yahya, Tata McGraw-Hill Publication, 4th Edition , 29 October 2010, ISBN: 9780070707023

Course Outcomes

After learning all the units of the course, the student is able to;

1. Analyze and predict the cycle performance of gas turbine engines.
2. Solve the problem for aircraft propulsion systems, in particular gas turbine engines.
3. Analyze and predict the performance of compressors, turbines, and combustion system.
4. Apply the dimensionless parameters involving different variables in predicting the performance of a gas turbine power plant.
5. Understand the environmental aspects of gas turbines.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	Analyze and predict the cycle performance of gas turbine engines.	**2**	**2**	**2**							**2**			**-**	**-**
CO2	Solve the problem for aircraft propulsion systems, in particular gas turbine engines.	**2**	**2**	**2**							**2**			**-**	**-**
CO3	Analyze and predict the performance of compressors, turbines, and combustion system.	**2**	**2**	**2**							**2**			**-**	**-**
CO4	Apply the dimensionless parameters involving different variables in predicting the performance of a gas turbine power plant.	**2**	**2**	**2**							**2**			**-**	**-**
CO5	Understand the environmental aspects of gas turbines.						**2**	**2**						**-**	**-**

Course Title: Total Quality Management (open Elective-I)			
Course Code: **P15ME751**	Semester: VII	L-T-P-H: 3-2-0-5	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at enabling the students to understand the basic concepts of TQM. Identify and develop appropriate tools solving of real life problems.

Course Content

UNIT-I

Introduction: Introduction, Definition, Basic approach, Gurus of TQM, Awareness, Defining Quality, Historical Review, Obstacles, Benefits of TQM, TQM Exemplary Organization, Exercises.

Leadership: Definitions, Characteristics of Quality Leaders, Leadership Concepts, The 7 Habits of Highly Effective People, Ethics, The Deming Philosophy, Role of TQM Leaders, Implementation, Quality Council, Core Values, Concepts and Framework, Quality Statements, Strategic Planning, Communications, Decision Marking, TQM Exemplary Organization, Exercises. **12 Hrs**

UNIT-II

Customer Satisfaction: Introduction, Who is the Customer?, Customer Perception of Quality, Feedback, Using Customer Complaints, Service Quality, Translating Needs into Requirements, Customer Retention, Additional Comments, TQM Exemplary Organization, Exercises.

Continuous Process Improvement: Introduction, Process, The Juran Trilogy, Improvement Strategies, Types of Problems, The PDSA Cycle, Problem-Solving Method, Kaizen, Reengineering, Six-Sigma, TQM Exemplary Organization, Exercises. **10 Hrs**

UNIT-III

Benchmarking: Introduction, Benchmarking Defined, Reasons to Benchmark, Process, Deciding What to Benchmark, Understanding Current Performance, Planning, Studying Others, Learning from the Data, Using The Findings, Pitfalls and Criticisms of Benchmarking, TQM Exemplary Organization, Exercises.

Quality Management Systems: Introduction, Benefits of ISO Registration, ISO9000 Series of standards, Sector-Specific Standards, ISO 9001 Requirements, Implementation, Documentation, Writing the Documents Internal Audits, Registration, Closing Comments, TQM Exemplary Organization, Exercises. **10 Hrs**

UNIT-IV

Environmental Management System: Introduction, ISO14000 Series Standards, Concepts of ISO 14001, Requirements of ISO 14001, Benefits of EMS, Integrating ISO 14000with ISO9000, Relationship to Health and safety Additional Comments, TQM Exemplary Organization, Exercises.

Statistical Process Control: Introduction, Pareto Diagram, Process Flow Diagram, Cause-and-Effect Diagram, Check Sheets, Histogram, Statistical Fundamentals, Introduction to Control Charts, State of Control, Out of Control Process, Process Capability, Different Control Charts for variables, Control Charts for Attributes, scatter Diagram, Summary, TQM Exemplary Organization Exercises. **10 Hrs**

UNIT-V

Quality Function Deployment: Introduction, The QFD Team, Benefits of QFD, The Voice of the Customer, Organization of Information, House of quality, QFD Process, Examples, Conclusion, TQM Exemplary Organization, exercises.

Quality by Design: Introduction, Rationale for Implementation Benefits, Teams, Communication Models, Implementation, Tools, Misconceptions and Pitfalls, TQM Exemplary Organization Exercises. **10 Hrs**

Text Books

1.Total Quality Management. Dale H. Besterfield et al. Pearson Publishers, New Delhi.
2.TQM. V K Khanna et al. New Age International Publishers, New Delhi.

Reference Books:

1. Total Quality Management. Dr.S Kumar. Laxmi Publications, New Delhi.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Tell who** are all the Gurus of TQM, Define Quality, Leadership Concepts.
2. **Explain Customer,Customer** Perception of Quality, Juran Trilogy, PDSA Cycle.
3. **Develop** Benchmarking process, **Make use of** ISO Registration
4. **Analyse** ISO14000 Series Standards. **Categorise** SPC tools.
5. **Build** QFD team and QBD

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Tell who** are all the Gurus of TQM, Define Quality, Leadership Concepts.			**3**											
CO2	**Explain** Customer,Customer Perception of Quality, Juran Trilogy, PDSA Cycle					**3**									
CO3	**Develop** Benchmarking process, **Make use of** ISO Registration										**3**				
CO4	**Analyse** ISO14000 Series Standards. **Categorise** SPC tools.				**3**										
CO5	**Build** QFD team and QBD									**3**					

Course Title: Operations Research (Open Elective-I)			
Course Code: **P15ME752**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs, : Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at enabling the students to understand the basic concepts of Operations Research. Identify and develop operation research models from the verbal description of real life and optimize the solutions.

Course Content

UNIT-I

Introduction: Definition, scope of Operations Research (O.R) approach and limitations of OR Models, Characteristics and phases of OR Mathematical formulation of Linear programming problems. Graphical solution for maximization and minimization problems. **10 Hrs**

UNIT-II

Linear Programming Problems: Simplex method – slack, surplus and artificial variables. Degeneracy and procedure for resolving degeneracy. Big M method, Two phase method, Dual simplex method. **12 Hrs**

UNIT-III

Transportation Problem: Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, maximization and minimization problems. Degeneracy in transportation problems, Applications of Transportation problems. **10 Hrs**

UNIT-IV

Network Analysis in Project Planning (PERT AND CPM): Project, Project planning, Project scheduling, Project Controlling, Network terminologies, PERT and CPM. (Excluding crashing of networks.). **10 Hrs**

UNIT-V

Game Theory: Introduction to game theory, Terminologies used in game theory, Formulation of games, Different strategies of games, Two people-Zero sum game, Games with and without saddle point, Algebraic method of solving games of 2 X 2 matrix, Graphical solution (2 x n, m x 2 game) and dominance property. **10 Hrs**

Text Books

1. Taha H. A **Operations Research and Introduction**,. Pearson Education edition
2. **Operation Research**, Prem Kumar Gupta, D.S. Hira, S Chand Pub,New delhi.2011

Reference Books

1. **Operation reaseach** AM Natarajan, P. Balasubramani , A Tamilaravari Pearson 2005
2. **Introduction to operation research**. Hiller and liberman, Mc Graw Hill. 5th edition 2001
3. **Operations Research**, Principles and practice: Ravindran, Phillips & Solberg, Wiley India lts, 2nd edition 2007.
4. S.D. Sharma **Operations Research**, Kedarnath Ramnath & Co 2002.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Identify** and develop operation research models from the verbal description of real life.
2. **Analyse** the problem using mathematical tools and simple queue system.
3. **Describe** the model and the solving technique to analyze the results and propose recommendation.
4. **Solve** Transportation and Assignment problem using different methods.
5. **Explain** the game theory with their characteristics and Solve problems.

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**												**PSO**	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** and develop operation research models from the verbal description of real life.	**3**			**3**	**3**								-	-
CO2	**Analyse** the problem using mathematical tools and simple queue system.	**2**												-	-
CO3	**Describe** the model and the solving technique to analyse the results and propose recommendation.					**3**								-	-
CO4	**Solve** Transportation and Assignment problem using different methods.					**2**								-	-
CO5	**Explain** the game theory with their characteristics and Solve problems.					**2**								-	-

Course Title: Renewable Energy Technology (Open Elective-I)			
Course Code: **P15ME753**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs, : Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at strengthening the design capabilities of the students by exposing them to the design of different mechanical elements that are commonly used in machines.

Course Content

UNIT-I

INTRODUCTION: Energy source, India's production and reserves of commercial energy sources, need for renewable energy sources, solar, photovoltaic, water power, wind, bio-mass, ocean temperature difference, tidal and waves, geothermal (Qualitative and Quantitative).

SOLAR RADIATION: Extra-terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam and global radiation, solar radiation data. **09 Hrs**

UNIT-II

SOLAR RADIATION MEASUREMENT: Pyranometer, shading ring, Pyrheliometer, sunshine recorder, schematic diagrams and principles of working. (no numericals)

SOLAR RADIATION GEOMETRY: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expression for the angle between the incident beam and the normal to a plane surface (No derivation), local apparent motion of sun, day length and simple numerical. **10 Hrs**

UNIT-III

SOLAR THERMAL CONVERSION: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters, concentrating collectors (cylindrical, parabolic, paraboloid), sensible heat storage, latent heat storage, application of solar energy water heating. Solar heating and cooling, solar thermal power plant and solar pond, principle of working, solar cells and its applications.

GEOTHERMAL ENERGY CONVERSION: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy. **11 Hrs**

UNIT-IV

WIND ENERGY: Availability of wind energy in India, wind machines: Types of wind machines and their characteristics, horizontal and vertical axis wind mills, problems associated with wind power.

TIDAL POWER: Tides and waves as energy suppliers and their mechanics, harnessing tidal energy, limitations.

OCEAN THERMAL ENERGY CONVERSION: Principle of working, Rankine cycle, problems associated with OTEC. **10 Hrs**

UNIT-V

ENERGY FROM BIOMASS: Biomass conversion Technologies, Photosynthesis, photosynthetic oxygen production, energy plantation, biogas production from organic wastes by anaerobic fermentation, description of biogas plants (KVIC digester), problems involved with biogas production, application of biogas in engines, advantages.

HYDROGEN ENERGY : Properties of Hydrogen with respect to its utilization as a renewable form of energy sources, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production and bio-chemical production. **10 Hrs**

Text Books

1. G.D Rai K, "**Non conventional energy sources**", Khanna publishers.2004, ISBN:9788174090737
2. Subhas P.Sukhatme, J K Nayak, "**Solar energy**", Tata Mc Graw Hill,India 3rd Edition. 2009, ISBN: 9780070142961

Reference Books

1. N.K.Bansal, Manfred Kleeman and Mechael meliss, "**Renewable energy sources and conversion technology"**, Tata Mcgraw Hill, 2001. ISBN:9780074600238
2. John W.Twidell, Tony Weir, "**Renewable energy resources**" , Routledge, 4th edition, 2014, ISBN:9780415633581

Course Outcomes

1. After learning all the units of the course, the student is able to;
   Identify production and reserves of commercial energy sources in India and Evaluate the availability of solar radiation.
2. Analyse solar energy with the help of solar radiation measuring instruments and Explain the angles related to solar radiation geometry.
3. Analyse and design solar collectors for harnessing solar energy. Discuss characteristics of geothermal energy.
4. Explain different types of wind mills and their design principles. Compute coefficient of performance of wind mill. Discuss characteristics of tidal energy, ocean thermal energy.
5. Discuss characteristics of biomass energy and Describe the methods of production of hydrogen for utilization as a renewable form of source of energy.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** production and reserves of commercial energy sources in India and **Evaluate** the availability of solar radiation.		**1**	**2**		**2**		**3**					**3**	-	-
CO2	**Analyse** solar energy with the help of solar radiation measuring instruments and **Explain** the angles related to solar radiation geometry.	**3**	**3**	**2**										-	-
CO3	**Analyse** and **design** solar collectors for harnessing solar energy. **Discuss characteristics** of geothermal energy.	**3**	**1**	**3**							**2**			-	-
CO4	**Explain** different types of wind mills and their design principles. **Compute** coefficient of performance of wind mill. **Discuss characteristics** of tidal energy, ocean thermal energy.	**3**									**3**			-	-
CO5	**Discuss characteristics** of biomass energy and **Describe** the methods of production of hydrogen for utilization as a renewable form of source of energy.										**3**		**3**	-	-

Course Title: Finite Element Method in Engineering (Open Elective-I)			
Course Code: **P15ME754**	Semester: VII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. Exam: 3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims to provide an introductory approach to finite element method as a basic numerical tool for solving mechanical engineering problems.

Course Content

UNIT-I

INTRODUCTION TO FEM: Need for use of FEM, Advantages and disadvantages of FEM, Engineering Applications of FEM, Steps involved in FEM, Discretization process – types of elements (1D,2D,3D), size of the elements, location of nodes, node numbering scheme, Body force and surface force, equilibrium equations of a body subjected to body force and traction force, strain- displacement relations, stress-strain relations, concept of plane stress and plane strain and their stress-strain relations. Principle of minimum potential energy and derivation of potential energy functional for a 3D elastic body. **10 Hrs**

UNIT-II

INTERPOLATION MODELS: Displacement function, selection of the order of displacement function, convergence criteria, geometric isotropy, Pascal's triangle for 2D polynomial, Different co-ordinate systems used in FEM. Interpolation or shape functions for 1D linear bar elements and 2D linear triangular (CST) element in Cartesian and natural co-ordinate systems. Lagrangian polynomial – Shape functions for linear quadrilateral element (QUAD 4). Iso-parametric, sub-parametric and super-parametric elements, Concept of Jacobian matrix, Jacobian matrix for CST element. **11 Hrs**

UNIT-III

ELEMENT STIFFNESS MATRIX AND LOAD VECTORS: Strain displacement matrix, Stiffness matrix and load vector for linear bar element. Strain displacement matrix and Stiffness matrix for CST element. Assembly of elements by direct stiffness method, special characteristics of stiffness matrix, Treatment of boundary conditions- elimination and penalty methods. Analysis of axially loaded uniformly tapered and stepped bars. **12 Hrs**

UNIT-IV

ANALYSIS OF PLANE TRUSSES: Introduction, local and global coordinate systems, transformation matrix, stiffness and stress matrices for plane truss element, analysis of truss members. **8 Hrs**

UNIT-V

ANALYSIS OF BEAMS: Introduction, Hermite shape function for beam element in Cartesian coordinates, Stiffness matrix and load vector for beam element, and analysis of beams.

ANALYSIS OF HEAT TRANSFER PROBLEMS: Steady state heat transfer, 1D heat conduction- governing equation, boundary conditions, one-dimensional element, Galerkin's approach to heat conduction problems, numericals on 1D heat transfer through composite wall. **11Hrs**

Text Books

1. Chandrakanth S Desai and J.F. Abel, **"Introduction to the Finite Element Method,"** CBS, 1st edition, 2005, ISBN: 978-8123908953.
2. T R Chandrupatla and A D Belegundu, **"Introduction to Finite Elements in engineering,"** Pearson, 4th edition, 19th October 2011, ISBN: 978-0132162746.
3. Singiresu S Rao, **"The Finite Element Method in engineering,"** Elsevier Publisher, 5th edition, 2008 ISBN: 978-9380931555.

Reference Books

1. O.C.Zienkiewicz, **"The FEM its basics and fundamentals,"** Elsevier Publisher, 6th edition, 2007, ISBN: 978-8131211182.
2. J.N.Reddy, **"Finite Element Method,"** McGraw Hill International Edition, 2005, ISBN:

9780072466850.
3 Daryl. L. Logon, **"Finite Element Methods,"** Thomson Learning 5th edition, 1st Jan 2011, ISBN: 978-0495668251.
4 David V. Hutton, **"Fundamentals of Finite Element Analysis,"** Tata McGraw Hill Publishing Co. Ltd, New Delhi, 10th June 2005, ISBN: 978-0070601222.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Understand** the basic concepts and mathematical preliminaries of FEM required to solve basic field problems.
2. **Develop** interpolation models for 1D and 2D elements that satisfy convergence criteria and geometric isotropy and **use** isoparametric concept in the finite element analysis.
3. **Formulate** element stiffness matrices and load vectors for different elements using variational principle and **analyze** axially loaded bars.
4. **Use** finite element formulations in the **determination** of displacements, stresses, and support reactions of trusses.
5. **Use** finite element methods to solve beam problems and 1D steady state head transfer problems.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Understand** the basic concepts and mathematical preliminaries of FEM required to solve basic field problems.	**3**	**2**	**2**	**2**	**1**							**1**	**2**	**-**
CO2	**Develop** interpolation models for 1D and 2D elements that satisfy convergence criteria and geometric isotropy and **use** isoparametric concept in the finite element analysis.	**3**	**3**	**3**	**2**	**2**	**1**						**2**	**3**	**-**
CO3	**Formulate** element stiffness matrices and load vectors for different elements using variational principle and **analyze** axially loaded bars.	**3**	**3**	**3**	**2**	**3**	**1**						**2**	**3**	**-**
CO4	**Use** finite element formulations in the **determination** of displacements, stresses, and support reactions of trusses.	**3**	**3**	**3**	**2**	**3**	**2**						**3**	**3**	**-**
CO5	**Use** finite element methods to solve beam problems and 1D steady state head transfer problems.	**3**	**3**	**3**	**3**	**3**	**2**				**-**		**3**	**3**	**-**

Course Title: Design Lab			
Course Code: **P15MEL76**	Semester: VII	L-T-P-H: 0-0-3-3	Credits: 1.5
Contact Period - Lecture: 36 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;SEE: 50%	

Course Objectives: This course enables the students to understand the basic concepts of natural frequency of spring-mass system, vibration characteristics of rotor, Pressure distribution in Journal bearing.

Course Content

Part A

1. Determination of natural frequency of single DOF undamped spring-mass free vibration system.
2. Determination of natural frequency of single DOF undamped equivalent spring-mass free vibration system.
3. Study of single DOF damped torsional free vibration system.
4. Study of forced vibration of single DOF equivalent spring - mass – damper system
5. Determination of natural frequency by Dunkerley's principle
6. Determination of critical speed of a rotating shaft.
7. Determination of vibration characteristics of rotor.

Part B

1.. Determination of Fringe constant of Photo elastic material using a Circular disc subjected to diametral compression.
2. Determination of stress concentration using Photo elasticity for a circular disk with circular hole under compression
3. Performance study of governors.
4. Determination of a Pressure distribution in Journal bearing
5. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
6. Determination of gyroscopic torque in a Gyroscope.

Reference Books

1. V.P. Singh**, Mechanical Vibrations,** Dhanpat Rai & Co (P) Ltd**., ISBN:** 1234567150209
2. S.S. Rattan, Theory of Machines, Tata McGraw-Hill, New Delhi, 4th edition, 2015, ISBN: 9789351343479.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Apply** principles of vibration and **determine** vibration characteristics of simple single degree of freedom systems experimentally.
2. **Determine** critical speed of shaft experimentally.
3. **Demonstrate** the basic principles of photoelasticity**. Determine** experimentally, stress concentration using polariscope.
4. **Demonstrate** experimentally pressure distribution in journal bearings.
5. **Demonstrate** the working principles of Governors and Gyroscope.
6. **Determine** experimentally, stresses induced in a cantilever beam subjected to combined bending and torsion, using strain rosette.

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**												**PSO**	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Apply** principles of vibration and **determine** vibration characteristics of simple single degree of freedom systems experimentally.	**1**	**2**		**3**					**2**	**2**			**-**	**1**
CO2	**Determine** critical speed of shaft experimentally.	**1**	**2**		**3**					**2**	**2**			**-**	**1**
CO3	**Demonstrate** the basic principles of photoelasticity**. Determine** experimentally, stress concentration using polariscope.	**2**	**2**		**3**					**2**	**2**			**-**	**-**
CO4	**Demonstrate** experimentally pressure distribution in journal bearings.		**2**		**3**					**2**	**3**			**-**	**1**
CO5	**Demonstrate** the working principles of Governors and Gyroscope.		**2**		**3**					**1**	**1**			**-**	**-**
CO6	**Determine** experimentally, stresses induced in a cantilever beam subjected to combined bending and torsion, using strain rosette.		**2**		**3**					**2**	**2**			**-**	**-**

Course Title: Simulations Lab			
Course Code: **P15MEL77**	Semester: VII	L-T-P-H: 0-0-3-3	Credits: 1.5
Contact Period - Lecture: 36 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: This course enables the students to simulate Turning, Drilling, Milling/Cutting operations using simulation packages, to build hydraulic circuits using single acting cylinder and double acting cylinder and to generate response plot of control system using MATLAB

Course Content

Part -A

1. Modeling of simple machine parts and generating machine codes for CNC production using standard CAM packages.
2. Simulation of Turning, Drilling, Milling/Cutting operations on a Computer using CAM packages.
3. Three typical simulations to be carried out using simulation packages like Master CAM, or any equivalent software. **21 Hrs**

Part- B

4. Design and building of hydraulic circuits using single acting cylinder and double acting cylinder and its analysis.
5. Unit-step response plot of control system using MATLAB, for (i) its open loop transfer function and (ii) its state-space equation and to determine rise time, peak time, maximum overshoot and settling time in the unit-step response plot.
6. Root locus plot, Bode plot and Nyquist plot of control systems using MATLAB, for (i) its open loop transfer function and (ii) its state-space equation. **15 Hrs**

Reference Books

1. P.N. Rao, **CAD/CAM** Principles and Application, Tata McGraw Hill, 3rd edition, 2010, ISBN: *0070681937*.
2. Groover, Computer Aided Design/Computer Aided Manufacturing, Tata McGraw Hill. 2003.
3. Rao V Dukkipati, Control Systems, Narosa Publishing House, 2008, ISBN: 978-8173195549.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Create** solid model of simple machine parts using Master CAM package.
2. **Show** simulation of Turning, Drilling, Milling using software
3. **Develop** MATLAB programs to plot step-response curve and determine transient response specifications.
4. **Develop** MATLAB programs to draw root locus, Nyquist and Bode plots of control systems.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	Create solid model of simple machine parts using Master CAM package.		**2**	**1**	**3**	**2**				**3**	**1**		**1**	**1**	**-**
CO2	Show simulation of Turning, Drilling, Milling using software		**2**		**1**	**2**				**2**	**1**			**1**	**-**
CO3	Develop MATLAB programs to plot step-response curve and determine transient response specifications.	**1**	**2**	**3**		**1**				**2**	**2**			**1**	**-**
CO4	Develop MATLAB programs to draw root locus, Nyquist and Bode plots of control systems.	**1**	**2**	**3**		**1**				**2**	**2**			**1**	**-**

Semester:-VIII

Course Title: Industrial Robotics			
Course Code**: P15ME81**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives:

- To familiarize students with brief history of robot and basic concepts of industrial robot.
- To expose the students to kinematics of robots and programming of robot
- To make the students familiar with various applications in robots in industry

Course Content

UNIT-I

INTRODUCTION: Automation and robotics, brief history of robotics, Classifications of robots, Geometrical configuration, Work Volume, wrist and its motions, links and joints. End Effectors: types of grippers, tools. Resolution, Accuracy and Repeatability, Problems. **10 Hrs**

UNIT-II

STRUCTURE OF ROBOTIC SYSTEM: Robot drive system: Hydraulic, electric and pneumatic drive system, advantages and disadvantages. Feedback components: position, velocity sensors, types of Actuators. Internal State sensors, tactile sensors, - proximity sensing, range sensing, force-torque sensors. **10 Hrs**

UNIT-III

ROBOT ARM KINEMATICS: Kinematics- Introduction, direct and inverse Kinematics, rotation Matrix, composite rotation matrix, rotation matrix about an arbitrary axis, Euler angles representation, homogeneous transformations D-H representation. Applications of DH method:-Three axis robot arm, Three axis wrist. **10 Hrs**

UNIT-IV

ROBOT PROGRAMMING: Introduction, manual teaching, lead through teaching, Robot programming languages:-Generations Robot programming Languages. Robot language elements and functions, Motion commands, End Effector and sensor commands, Program control and subroutines. Programs. **10 Hrs**

UNIT-V

APPLICATIONS OF ROBOTS IN MANUFACTURING: Material Transfer:- general considerations in robot material handling, pick and place, palletizing operations. Machine Loading & unloading: Die casting, Plastic moulding, Forging, machining and stamping press operations. Processing Operations:- spot and arc welding, features of arc welding robot, spray coating and other processing applications. Robotic assembly operation, Parts presentation methods, Assembly system configurations. **10 Hrs**

Text Books

1. Michell Grover, Mitchel weiss, Roger nagel **"Industrial Robots",** McGraw Hill 2012, India, 2ND edition, ISBN-13:9780070265097
2. K.S. Fu, R.C. Gonzales and Lee, **"Robotics"**. McGraw Hill Intl. India, 1ST edition, 2008 ISBN-13:9780070265103
3. Yoramn Koren, **"Robotics for Engineers"** Mc Graw hill Intl. Book Co., New Delhi 1987 ISBN-13:9780070353992

Reference Books

1. Robert J. Schilling, **"Fundamentals of Robotics"** PHI**, 1ST** edition-.2011, ISBN-13:9788120310476
2. Richard D. Klafter,C Thomas A, "**Robotic Engineering"** PHI,1993, ISBN-13:9788120308428
3. R.K. Mittal and J. Nagarath, **"Robotics and Control"** Tata Mc Graw Hill, DELHI,6TH edition 2007, ISBN:0070482934

Course Outcomes

After learning all the units of the course, the student is able to;

1. Analyze work volume, resolution, and accuracy of various configuration of robots
2. Identify different types of end effectors and sensors required for specific applications
3. Calculate the forward kinematics of robots using DH method
4. Develop robot task program using robot language
5. Discuss requirements of robot systems for various industrial applications.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Analyze** work volume, resolution, and accuracy of various configuration of robots	**2**	**2**	**1**	**1**									-	-
CO2	**Calculate** the forward kinematics of robots using DH method	**3**	**2**	**1**	**1**									-	-
CO3	**Identify** different types of end effectors and sensors required for specific applications										**2**		**2**	-	-
CO4	**Develop** robot program using robot languages					**2**					**2**		**2**	-	-
CO5	**Discuss** various applications of industrial robot systems.					**1**					**2**		**2**	-	**1**

Course Title: Operations Research

Course Code**: P15ME821**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at enabling the students to understand the basic concepts of Operations Research. Identify and develop operation research models from the verbal description of real life and optimise the solutions.

Course Content

UNIT-I

INTRODUCTION: Definition, scope of Operations Research (O.R) approach and limitations of OR Models, Characteristics and phases of OR Mathematical formulation of L.P. Problems. Graphical solution for maximization and minimization problems. **12Hrs**

UNIT-II

LINEAR PROGRAMMING PROBLEMS: Simplex method – slack, surplus and artificial variables. Degeneracy and procedure for resolving degeneracy. Big M method, Two phase method, dual simplex method. **10 Hrs**

UNIT-III

TRANSPORTATION PROBLEM: Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, maximization and minimization problems. Degeneracy in transportation problems, Applications of Transportation problems. **10 Hrs**

UNIT-IV

ASSIGNMENT PROBLEM: Formulation, balanced and unbalanced assignment problem-Hungarian method, Travelling salesman problem. **10 Hrs**

UNIT-V

QUEUING THEORY: Queuing system and their characteristics. The M/M/1 Queuing system, Steady state performance analyzing of M/M/ 1 System.

GAME THEORY: Formulation of games, two people-Zero sum game, games with and without saddle point, Graphical solution (2 x n, m x 2 game) and dominance property. **10 Hrs**

Text Books

1. Taha H. A **Operations Research and Introduction**,. Pearson Education edition
2. **Operation Research**, Prem Kumar Gupta, D.S. Hira, S Chand Pub,New delhi.2007

Reference Books

1. **Operation reaseach** AM Natarajan, P. Balasubramani , A Tamilaravari Pearson 2005
2. **Introduction to operation research**. Hiller and liberman, Mc Graw Hill. 5th edition 2001
3. **Operations Research**, Principles and practice: Ravindran, Phillips & Solberg, Wiley India lts, 2nd edition 2007.
4. S.D. Sharma **Operations Research**, Kedarnath Ramnath & Co 2002.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Identify** and develop operation research models from the verbal description of real life.
2. **Analyse** the problem using mathematical tools and simple queue system.
3. **Describe** the model and the solving technique to analyze the results and propose recommendation.
4. **Solve** Transportation and Assignment problem using different methods.
5. **Explain** the game theory with their characteristics and Solve problems.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** and develop operation research models from the verbal description of real life.	**3**			**3**	**3**								-	-
CO2	**Analyse** the problem using mathematical tools and simple queue system.	**2**												-	-
CO3	**Describe** the model and the solving technique to analyse the results and propose recommendation.					**3**								-	-
CO4	**Solve** Transportation and Assignment problem using different methods.					**2**								-	-
CO5	**Explain** the game theory with their characteristics and Solve problems.					**2**								-	-

Course Title: Foundry & Welding Technology			
Course Code**: P15ME822**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam: 3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at understanding and strengthening knowledge of advancements in Foundry and welding technology to the students by exposing them to different Foundry and welding techniques that are commonly used in industries.

Course Content

UNIT-I

SOLIDIFICATION OF CASTINGS: Introduction- concept of solidification of metals- solidification of pure metals- nucleation, homogeneous or self-nucleation, heterogeneous nucleation- growth- solidification of alloys, alloyed metal characteristics, main types of alloys, solid solution alloys, their characteristics, and solidification, phase diagram, coring or segregation, types of segregation, solute distribution, - solidification phenomenon and grain structure, mechanism of dendrite, formation and dendrite growth- solidification rate, time and chvorinov's rule- progressive, directional solidification and control of solidification to obtain sound castings.

METALLURGY OF CAST STEEL: Composition, structure, control of properties, macrostructure, microstructure, inclusions, Heat- treatment, annealing, normalizing, stress relief anneal, liquid quench and temper. Alloy steels, measurement of hardenability and its significance, production heat treating. **10 Hrs**

UNIT-II

PRINCIPLES OF GATING: Gating System- Requirements, purposes of functions of the gating system- pouring cups and basins- spruers- gates, their characteristics and different types- design of gating system, objectives achieved from good design, defects occurring due to improper design of gating system, turbulence in gating system, metal flow rate and velocity calculations, design criteria for pouring basin, design of sprue, pouring time, design of runner and gates, pressurized and unpressurized gating system, streamlining the gating system, practical rules for gating practice, elimination of slag and dross for copper, ferrous and light metal alloys.

PRINCIPLES OF RISERING: Introduction- Functions of a riser- types of riser, open and blind risers- Riser and Directional solidification- increasing riser efficiency and promoting directional solidification, insulating materials, exothermic materials, chills, padding etc. – Feeder Head (or riser system) Design, general principles, riser shape, riser size, Chvorinove's rule, riser location and riser feeding distance- Risering practice for alloys- Heat loss from risers. **10 Hrs**

UNIT-III

CASTING DESIGN CONSIDERATIONS: functional design, mechanical strength, dimensional design factors, simplification of foundry practice, molding and coring,elimination of coring, metallurgical design,

SHAKEOUT/ CLEANING/ FINISHING: shakeout- modern developments, punchout machines, shakeout tables and decks, high frequency shakeouts, vibrating shakeout conveyors, rotary separators, robots and manipulators, - fettling(cleaning) and finishing of castings- removal of cores- cleaning of castings surfaces, hand methods and mechanical methods,- blast cleaning- process control- blast cleaning abrasives- air blasting- mechanical blast cleaning (wheelabrator system)- hydro blasting- safety considerations when blast cleaning nonferrous casting, chemical cleaning, removal of gates and riser- removal of fins and other unwanted projections from castings- finishing of castings- grinding castings, robots for grinding, manipulators, trim dies, abrasive products- surface treatment of castings. **10 Hrs**

UNIT-IV

WELDING PROCESSES: Classification of Welding and allied processes, cast weld processes: Thermit welding, Electroslag welding, Arc and Flame welding processes: Seam welding & Arc spot welding processes, Resistance welding processes: Spot welding, Seam

welding, Zonal welding processes, Solid state welding processes: High heat input and Low heat input processes, Allied processes: Material joining processes, Thermal cutting processes, Modes of Welding: manual welding, semiautomatic welding, automatic welding, automated welding(flexible welding system), positions in welding.

CRACKS IN WELDING: introduction, classifications in weld cracks, Hot and Cold cracks, Nomenclature, Location & Orientation of weld cracks: Weld metal cracks, Base metal cracks, Factors contribution to weld Cracking, Specific weld cracks: Chevron cracks, lamellar cracks, reheat cracking, stress corrosion cracking **11 Hrs**

UNIT-V

DEFECTS IN WELDING: Classification of weld defects, General sources of weld defects, Arc welding defects: surface or visual defects, subsurface weld defects, Acceptance levels of arc welding defects, Weld defects in other arc welding processes: Resistance welding defects, defects in friction welding, defects in welds of other welding processes.

WELD INSPECTION AND QUALITY CONTROL: Introduction, visual inspection and measurement: equipment, visual inspection, Destructive tests, Non-Destructive tests(NDT): liquid penetrate testing, magnetic particle testing, eddy current testing, magneto graphic test, radiographic testing, ultrasonic testing, acoustic emission testing, comparison of NDT methods, Pressure and Leak testing: kerosene test, hydrostatic pressure testing, air pressure or pneumatic testing, vacuum testing, halide testing, helium test. **11 Hrs**

Text Books

1. CARL R Loper & PHILIP C Rosenthal, Richard W Heine, "**Principle of metal casting" ,** TMH-2001, ISBN-13:9780070993488
2. P.L.Jain, "**Principle at Foundry Technology",** MH education (India) ltd., 5th edition 2009, ISBN-13:9780070151291.
3. Dr R S Parmar, "**Welding Engineering and Technology" ,** Khanna publications, 2nd edition, 2004, ISBN-13:9788174090287

Reference Books

1. John Campbell, **"Casting",** Butterworth heinnmann, 2nd edition, 2004, ISBN-13:9780750647915
2. P.N.Rao, "**Manufacturing technology Foundry, forming and welding",** McGraw Hill , 4th edition volume 1, 2013,ISBN: 9789383286614
3. Dr. K. Radha Krishna, "**Manufacturing process** I", Sapna Book House, Bangalore. 5th Edition.2006, ISBN:8128002074

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Explain** concept of solidification of metals- solidification of pure metals- nucleation, homogeneous or self nucleation, heterogeneous nucleation- growth- solidification of alloys**.**
2. **Describe** gating System- Requirements, purposes of functions of the gating system- pouring cups and basins- spruers- gates, their characteristics and different types- design of gating system, objectives achieved from good design, defects occurring due to improper design of gating system
3. **Explain** shakeout- modern developments, punchout machines, shakeout tables and decks, high frequency shakeouts, vibrating shakeout conveyors, rotary separators, robots and manipulators, - fettling(cleaning) and finishing of castings- removal of cores- cleaning of castings surfaces, hand methods and mechanical methods
4. **Describe** classification of Welding and allied processes, cast weld processes: Thermit welding, Electroslag welding, Arc and Flame welding processes: Seam welding & Arc spot welding processes, Resistance welding processes: Spot welding, Seam welding, Zonal welding processes

5. **Discus** Weld defects in other arc welding processes: Resistance welding defects, defects in friction welding, defects in welds of other welding processes. **Explain** , Non-Destructive tests(NDT): liquid penetrate testing, magnetic particle testing, eddy current testing, magnetographic test, radiographic testing

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Explain** Oxidation of liquid metals, gas dissolution in liquid metals, methods of degassing, fluidity, factors affecting fluidity, fluidity tests, hot tearing, shrinkage of liquid and metals**.**	**1**				**2**				**3**				**-**	**-**
CO2	**Describe** Structure of castings -significance and practical control cast structure, grain shape and orientation, grain size, refinement and modification of cast structure			**3**			**2**		**1**					**-**	**-**
CO3	**Explain** Need for risering, general considerations of risering, riser shapes, riser size and location. Requirements of riser. Sand, insulation, and exothermic materials used for risers													**-**	**-**
CO4	**Describe** Classification of Welding and allied processes, cast weld processes: Thermit welding, Electroslag welding, Arc and Flame welding processes: Seam welding & Arc spot welding processes, Resistance welding processes: Spot welding, Seam welding, Zonal welding processes		**2**		**1**			**3**						**-**	**-**
CO5	**Discus** Weld defects in other arc welding processes: Resistance welding defects, defects in friction welding, defects in welds of other welding processes. **Explain** , Non-Destructive tests(NDT): liquid penetrate testing, magnetic particle testing, eddy current testing, magnetographic test, radiographic testing	**3**		**2**							**1**			**-**	**-**

Course Title: Renewable Energy Technology			
Course Code**: P15ME823**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %; SEE: 50%	

Course Objectives: The course aims at strengthening the design capabilities of the students by exposing them to the design of different mechanical elements that are commonly used in machines.

Course Content

UNIT-I

INTRODUCTION: Energy source, India's production and reserves of commercial energy sources, need for renewable energy sources, solar, photovoltaic, water power, wind, Wind-Hybrid Solar, bio-mass, ocean temperature difference, tidal and waves, geothermal (Qualitative and Quantitative).

SOLAR RADIATION: Extra-terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam and global radiation, solar radiation data**.** **09 Hrs**

UNIT-II

SOLAR RADIATION MEASUREMENT: Pyranometer, shading ring, Pyrheliometer, sunshine recorder, schematic diagrams and principles of working. (no numericals)

SOLAR RADIATION GEOMETRY: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent motion of sun, day length and numerical examples. **10 Hrs**

UNIT-III

SOLAR THERMAL CONVERSION: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid), sensible heat storage, latent heat storage, application of solar energy water heating. Solar heating and cooling, active and passive systems, power generation, refrigeration. Distillation, solar pond, principle of working, operational problems, Solar cells and its applications

GEOTHERMAL ENERGY CONVERSION: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy. **11 Hrs**

UNIT-IV

WIND ENERGY: Availability of wind energy in India, wind velocity and power from wind, major problems associated with wind power, wind machines: Types of wind machines and their characteristics, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor.

TIDAL POWER: Tides and waves as energy suppliers and their mechanics, harnessing tidal energy, limitations.

OCEAN THERMAL ENERGY CONVERSION: Principle of working, Rankine cycle, problems associated with OTEC. **10 Hrs**

UNIT-V

ENERGY FROM BIO MASS: Biomass **conversion** Photosynthesis, photosynthetic oxygen production, energy plantation, biogas production from organic wastes by anaerobic fermentation, description of biogas plants, problems involved with biogas production, application of biogas in engines, advantages.

HYDROGEN ENERGY :properties of Hydrogen with respect to its utilization as a renewable form of energy sources, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos chemical production and bio-chemical production. **10 Hrs**

Text Books

1. G.D Rai K, "**Non conventional energy sources**", Khanna publishers.2004, ISBN:9788174090737
2. Subhas P.Sukhatme, J K Nayak, "**Solar energy**", Tata Mc Graw Hill,India 3rd Edition. 2009, ISBN: 9780070142961

Reference Books

1. N.K.Bansal, Manfred Kleeman and Mechael meliss, "**Renewable energy sources and conversion technology"**, Tata Mcgraw Hill, 2001. ISBN:9780074600238
2. John W.Twidell, Tony Weir, "**Renewable energy resources**" , Routledge, 4th edition, 2014, ISBN:9780415633581

Course Outcomes

1. After learning all the units of the course, the student is able to;
2. **Identify** production and reserves of commercial energy sources in India and **Evaluate** the availability of solar radiation.
3. **Analyse** solar energy with the help of solar radiation measuring instruments and **Explain** the angles related to solar radiation geometry.
4. **Analyse** and **design** solar collectors for harnessing solar energy. **Discuss characteristics** of geothermal energy.
5. **Explain** different types of wind mills and their design principles. **Compute** coefficient of performance of wind mill. **Discuss characteristics** of tidal energy, ocean thermal energy.
6. **Discuss characteristics** of biomass energy and **Describe** the methods of production of hydrogen for utilization as a renewable form of source of energy.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** production and reserves of commercial energy sources in India and **Evaluate** the availability of solar radiation.		1	2		**2**		**3**					**3**	-	-
CO2	**Analyse** solar energy with the help of solar radiation measuring instruments and **Explain** the angles related to solar radiation geometry.	**3**	**3**	**2**										-	-
CO3	**Analyse** and **design** solar collectors for harnessing solar energy. **Discuss characteristics** of geothermal energy.	**3**	1	3							**2**			-	-
CO4	**Explain** different types of wind mills and their design principles. **Compute** coefficient of performance of wind mill. **Discuss characteristics** of tidal energy, ocean thermal energy.	3									**3**			-	-
CO5	**Discuss characteristics** of biomass energy and **Describe** the methods of production of hydrogen for utilization as a renewable form of source of energy.										**3**		**3**	-	-

Course Title: Computational Fluid Dynamics			
Course Code**: P15ME824**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %; SEE: 50%	

Course Objectives: This course will prepare students in the fundamentals of the computational approach to study fluid flow and heat transfer problems, and will provide a deeper understanding of the physical models and governing equations of fluid dynamics. It will also impart the knowledge of numerical techniques to the solution of fluid dynamics and heat transfer problems.

Course Content

UNIT-I

GOVERNING EQUATIONS: Basics of computational fluid dynamics, Comparison of experimental, theoretical and computational approaches, 3-D general mass conservation, momentum and energy equations in differential form, integral form and vector representation Cartesian and curvilinear co-ordinates (no derivations). Forms of the governing equations particularly suited for CFD work: Generic form of equations. **12 Hrs**

UNIT-II

PARTIAL DIFFERENTIAL EQUATIONS (PDE): Classification of PDE - physical & mathematical classification of PDE - equilibrium problems, marching problems, Cramer rule and Eigen value method, hyperbolic, parabolic and elliptic forms of equations and their physical behavior. Physical boundary conditions. **09 Hrs**

UNIT-III

FINITE DIFFERENCE METHOD: Derivation of finite difference equations for first and second order accuracy,- different numerical schemes –Explicit and Implicit approach - upwind, downwind, FTCS, etc., truncation error, Round-off and discretization errors and analysis of stability, Error propagation, Stability properties of Explicit and Implicit methods, numerical dissipation and numerical dispersion. Application of numerical methods to selected model Equations: Wave equation, Heat equation, Laplace equation. **11 Hrs**

UNIT-IV

FINITE VOLUME METHOD FOR DIFFUSION: Finite volume formulation of steady state One dimensional diffusion problems. Simple problem solving, Finite volume methods for diffusion equation. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit. **10 Hrs**

UNIT-V

FINITE VOLUME METHOD FOR CONVECTION - DIFFUSION

Finite volume formulation of steady state One dimensional convection-diffusion problems – Central, upwind, Hybrid, Power-law, QUICK differencing schemes. Properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness. **10 Hrs**

Text Books

1. **J**ohn c. tannehill, Dule A Anderson, Richard H Pletcher, "**Computational fluid mechanics and Heat transfer",** CRC press, 3rd edition, April 15, 2011, ISBN-13: 9781591690375
2. Suhas.V Patankar " **Numerical Heat Transfer and Fluid Flow**", CRC Press 1980,ISBN-13:9780891165224
3. Versteeg, H.K., and Malalasekera, W. "**An Introduction to Computational Fluid Dynamics-The finite volume Method**", Pearson, 2ND edition, 2007. ISBN-13:9780131274983

Reference Books

1. T.J. Chung, "**Computational Fluid Dynamics"**, Cambridge University Press, 2nd edition, 2010, ISBN-13:9780521769693
2. John D.Anderson, Jr. **"Computational fluid Dynamics- The basics with applications"**

McGraw-Hill, Inc.1995, ISBN-13:9780070016859
3. Muralidhar, K., and Sundararajan, T. "**Computationsl Fluid Flow and Heat Transfer"**, Narosa Publishing House, New Delhi, 2nd edition, 2009, , ISBN-13:9788173195228.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Apply** the differential equations governing fluid flow and heat transfer .
2. **classify** and **understand** behaviour of partial differential equations
3. **understand and develop** finite difference discretizations schemes and implement them to solve engineering problems
4. **understand** the importance and implications of analytical issues: consistency, stability, convergence, error analysis.
5. **understand and develop** finite volume discretization schemes and implement them to solve engineering problems

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Apply** the differential equations governing fluid flow and heat transfer .	**2**	**2**		**2**	**3**		**1**	**2**	**2**	**2**		**1**	**-**	**-**
CO2	**classify** and **understand** behavior of partial differential equations	**2**	**2**								**2**			**-**	**-**
CO3	**understand and develop** finite difference discretization's schemes and implement them to solve engineering problems	**2**	**2**	**1**	**2**	**3**			**2**	**2**	**2**	**2**	**1**	**1**	**-**
CO4	**Understand** the importance and implications of analytical issues: consistency, stability, convergence, error analysis.	**2**	**2**								**2**			**1**	**-**
CO5	**understand and develop** finite volume discretization schemes and implement them to solve engineering problems	**2**	**2**	**1**	**2**	**3**			**2**	**2**	**2**	**2**	**1**	**1**	**-**

Course Title: Project Management			
Course Code**: P15ME831**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at strengthening the design capabilities of the students by exposing them to the design of different mechanical elements that are commonly used in machines.

Course Content

UNIT-I

Concepts of Project Management: Concepts of a Project, Characteristics of a project, Categories of projects, Phases of project life cycle, Roles and responsibilities of project leader, tools and techniques for project management. PROJECT PLANNING AND ESTIMATING: Feasibility report phased Planning, Project planning steps, Objectives and goals of the project, preparation of cost estimation, and evaluation of the project profitability. **10 Hrs**

UNIT-II

Organizing and Staffing: The Project Team: Skills / abilities required for project manager, Authorities and responsibilities of project manager, Project organization and types accountability in project execution, controls, tendering and selection of contractors. **11 Hrs**

UNIT-III

Project Scheduling: Project implementation scheduling, different scheduling techniques bar (GANTT) charts, Bar charts for combined activities. Project evaluation and Review Techniques, PERT, planning. Simple Numerical Problems. **10 Hrs**

UNIT-IV

Co-Ordination and Control: Project direction, Communication in a project, Project coordination, Role of MIS in project control, performance control, schedule control, cost Control Examples. **11 Hrs**

UNIT-V

Performance Measures in Project Management: Performance indicators, Performance improvement-Do-It-Yourself, Performance improvement for the CM and DM companies for better project management. CLOSING OF PROJECT: Types of project termination, strategic implications, project in trouble, termination strategies, evaluation of termination possibilities. **10 Hrs**

Text Books

1. Harold Kerzner, "**Project Management: A Systems Approach To Planning, Scheduling And Controllin**g", Wiley India Pvt. Ltd. New Delhi, Feb18, 2013- ISBN: 9781118022276
2. Lawrence P Leach, "**Project Management**", Mc-Graw Hill (1970), Artech house 2014 3rd edition , ISBN:9781608077342

Reference Books

1. James P. Lewis, "Project planning, Scheduling & control", Mc-Graw Hill education, 5th edition, 2010, ISBN: 9780071746526
2. S Choudhury, "Project Management", TATA Mc-Graw Hill, 1989, ISBN:9780074600689.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Define** and **Recognise** project management stages
2. **Write** Feasibility report,
3. **Illustrate** Project implementation scheduling.
4. **Demonstrate** Performance improvement.
5. **Identify** project in trouble.

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**												**PSO**	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Define** and **Recognise** project management stages	2												-	-
CO2	**Write** Feasibility report,			2	**2**									-	-
CO3	**Illustrate** Project implementation scheduling.	2										**2**		-	-
CO4	**Demonstrate** Performance improvement.								**1**			**2**		-	-
CO5	**Identify** project in trouble.	2				**2**								-	-

Course Title: Additive Manufacturing Techniques			
Course Code**: P15ME832**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%
Course Objectives: This course exposes students to latest additive manufacturing processes used to produce prototypes, parts and tools.			
Course Content			
UNIT-I INTRODUCTION: Need for the compression in product development, history of AM systems and classification of AM systems, basic steps in AM, advantages and disadvantages of AM process. LIQUID BASED AM PROCESS: Stereo lithography Systems**:** Principle, Process parameter, process details, merits and demerits, Applications. Solid Ground Curing**:** Principle of operation, process parameters, merits and demerits, Applications. **10 Hrs**			
UNIT-II POWDER BASED AM PROCESSES**:** Selective Laser Sintering**:** Principle of operation, process parameters, merits and demerits, Applications. Laser Engineering Net Shaping: Principle of operation, process details, merits and demerits, applications. SOLID BASED AM PROCESSES**:** Laminated Object Manufacturing: Principle of operation, LOM materials, process parameters, process details, merits and demerits, application. Fusion Deposition Modelling: Principle, Process parameter, Path generation, merits and demerits, Applications. **11 Hrs**			
UNIT-III APPLICATIONS OF ADDITIVE MANUFACTURING: Functional Models, Pattern for Investment and Vacuum Casting, Medical Models, Art Models, Engineering Analysis Models. CONCEPTS MODELERS: Principle, types, difference between AM machine and Concept modeler, Thermal jet printer, Sander's model maker, 3- D printer. Genisys Xs printer, JP system 5, Object Quadra systems. **10 Hrs**			
UNIT-IV RAPID TOOLING: Classification of Rapid tools, Soft Tooling vs. Hard Tooling. Indirect Rapid tooling: - Silicone rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, Cast kirksite, 3D keltool. Direct Rapid Tooling: - Direct AIM, Quick cast process, RapidSteel1.0, RapidSteel 2.0, Copper polyamide, DMLS, Prometal, Sand casting tooling, Laminate tooling. DTM RapidToo1. **11 Hrs**			

UNIT-V

RAPID MANUFACTURING AND PROCESS OPTIMIZATION: Factors influencing accuracy. Data preparation errors, errors due to Tessellation and slicing Part building errors in SL process and SLS process, Error in finishing, influence of part build orientation in SL process and SLS process. **10 Hrs**

Text Books

1. Paul F.Jacobs, "**Stereo lithography and other RP & M Technologies" -**SME, NY 1995.ISBN-13:9780872634671
2. Pham D.T & Dimov, S.S Verlog, "**Rapid Manufacturing"** springer, London 9 November 2011, ISBN-13:9781447111825

Reference Books

1. Wohlers, Terry T, "**Rapid Prototyping"** Wohler's Report 2000, Wohler's Association 2000. **Wohlers Report 2015**, 314-page publication, Wohlers Associates, Inc., April 2015
2. Gurumurthi, **Rapid prototyping materials,** IISc Bangalore
3. LamOnt wood, "**Rapid automated"** Industrial press, New York, August 1, 1993, ISBN-13: 9780831130473

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Identify** Classification of AM systems.
2. **Describe** working principle and applications of major AM systems
3. **Distinguish** AM Machine and Concept Modelers
4. **Explain** different types of rapid tooling
5. **Identify** factors influencing part accuracy in AM

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** AM systems based on raw materials used.	**2**	**1**	**1**										-	-
CO2	**Compare** various AM process	**2**	**1**	**1**										-	-
CO3	**Distinguish** between AM machines and concept modelers.	**2**	**1**	**1**										-	-
CO4	**Explain** Direct and Indirect rapid tool	**2**	**1**	**1**										-	-
CO5	**Distinguish** between part building errors in SL and SLS process	**3**	**1**	**1**										-	-

Course Title: Power Plant Engineering			
Course Code**: P15ME833**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: the course is helps the student to understand about power plants and its working and the student must able understand the importance of renewable sources.

Course Content

UNIT-I

A BRIEF ACCOUNT OF HARNESSING ENERGY: From sources such as fuels, flowing water, wind, ocean, tides and waves, geothermal and nuclear energy. A brief description of thermionic, thermoelectric and fuel cell energy conversion devices. Choice of site for power station: load estimation; use factor, diversity factor and demand factors effect of variable load on power plant: selection of the number and size of units. **10 Hrs**

UNIT-II

HYDROELECTRIC AND THERMAL POWER PLANT: Hydrometric survey, rainfall, catchment area, runoff, storage and poundage; flow duration and mass curves, hydrographs. Classification of hydroelectric plants. General arrangement of a hydroelectric plant and its operation. General layout of Steam power plant. Developing trends in thermal coal in lump form stokers; different types of stokers, equipment for preparation and burning of pulverized coal, unit system and bin system, pulverized fuel furnaces, cyclone burners. **11 Hrs**

UNIT-III

GENERATION OF STEAM: A brief account of Lamont, Benson, Loeffler and Ramsin steam generators. Chimneys: Natural, forced, induced and balanced draft.

STEAM GENERATOR ACCESSORIES: Super-heaters and re-heaters. Different types of cooling towers, Coal and ash handling - different types of coal storage and coal conveyors, pneumatic and hydraulic methods of ash handling systems. **11 Hrs**

UNIT-IV

DIESEL ENGINE PLANT-Engines for power generation, Method of starting diesel engines, Cooling and lubrication system for the diesel engine. Filters, centrifuges, Oil heaters, intake and exhaust system, Layout of a diesel power plant. Gas turbine power plant: Advantages and disadvantages of the gas turbine plant, Open and closed cycle turbine plants with the accessories. **10 Hrs**

UNIT-V

NUCLEAR ENERGY: Fusion and fission reaction; elements of a nuclear reactor-moderator, control rod, fuel rods coolant. Nuclear fuels. Layout of a typical nuclear power plant.

REACTORS: Pressurized water reactor, Boiling water reactor, Sodium-Graphite reactor, Fast Breeder reactor and Gas cooled reactor. Radiation hazards; shielding, and radioactive waste disposal. **10 Hrs**

Text Books

1. Arora& S Domkundwar, AV Domkundwar, "A course in Power Plant Engineering", Dhanpatrai& co. Pvt.ltd.2014, ISBN:9788177001075
2. P. K. Nag, "Power Plant Engineering" Tata McGraw Hill, INDIA 4TH edition. 2014, ISBN:9789339204044
3. F.T. Morse, "Power Plant Engineering", G. Van Nostrand. 3rd edition 1953, ISBN:9780442055561

Reference Books

1. Barrows,Water power Engineering, TMH, New Delhi, 3rd edition, 1998
2. Stanierr,Plant Engineering, Hand Book, McGraw Hill. 1998
3. JagadishLal, "Hydraulic Machines" Metropollitan Book Co. Pvt Ltd., 1994.ISBN: 978-8120000261

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Discuss** energy sources such as fuels, flowing water, wind, ocean, tides, waves, geochemical, nuclear energy and **Calculate** load estimation, use factor and demand factor.
2. **Characterize** the working principle of Hydroelectric power plant and **Describe** different types of stokers and oil burners in thermal power plant.
3. **Discuss** generation of steam by using high pressure boilers.
4. **Discuss** Steam Generator Accessories, Method of starting Diesel Engine to generate power, Cooling and Lubrication System and Layout of diesel Power plant.
5. **Recognize** the Principles of Nuclear Energy and **Describe** different types of nuclear Reactors.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Explain** energy sources such as fuels, flowing water, wind, ocean, tides, waves, geochemical, nuclear energy and **Analyze** the load estimation, use factor and demand factor.	**3**	**3**											-	-
CO2	**Summarize**the working principle of Hydroelectricpower plant and different types of stokers and oil burners in thermal power plant.			**2**										-	-
CO3	**Explain**generation of steam by using high pressure boilers and **solve height**and efficiency ofChimney.	**3**	**3**										**1**	-	-
CO4	**Explain**Steam Generator Accessories, Method of starting Diesel Engine to generate power, Cooling and Lubrication System and Layout of diesel Power plant.	**3**		**1**										-	-
CO5	**Define** the Principles of Release in Nuclear Energy and **Explain**different types of nuclear Reactors.		**1**				**1**							-	-

Course Title: Tribology			
Course Code**: P15ME834**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at strengthening the capability of students to integrate friction, wear and lubrication theories in design, manufacturing and operation of sustainable machine elements and their maintenance.

Course Content

UNIT-I

Introduction to Tribilogy: Introduction to tribology, friction, laws of friction, friction theories, surface contaminants and frictional heating. Wear- classification of wear, mechanisms of wear, basic wear testing methods- pin on disc wear tester and dry sand rubber wheel abrasion tester, wear resistant materials.

Surface roughness: introduction, standardization of surface roughness, M & E system, center line average, root mean square roughness, probability distribution function, autocorrelation function. Abbott bearing area curve. Surface roughness measurement techniques- stylus method, interferometric method, optical profilometer and pneumatic method. **10 Hrs**

UNIT-II

Lubricants and Lubrication: Types of bearing, lubricants, types of lubricants. Lubrication, types of sliding lubrication-fluid-film lubrication, boundary lubrication and extreme boundary lubrication. Properties of oils and equation of flow- viscosity, Newton's law of viscous flow, effect of temperature on viscosity, viscosity index, effect of pressure on viscosity, viscosity measuring apparatus- U-tube viscometer, Say bolt universal viscometer and Redwood viscometer. Hagen- Poiseuille Law, flow through capillary tube, flow between parallel stationary plates. **10 Hrs**

UNIT-III

Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, coefficient of friction for a lightly loaded bearing (Petroff's equation), numerical examples of lightly loaded full-journal bearing, Tower's experiments, Reynolds investigations, mechanism of pressure development in an oil film, application of converging oil film in thrust bearing, formation of a converging oil film in a partial and full journal bearings. Reynold's equation in two dimensions. **10 Hrs**

UNIT-IV

Idealized Hydrodynamic Bearings: Definition of idealized bearings, idealized plane-slider bearing with a fixed shoe- Pressure distribution, load carrying capacity, coefficient of friction. Idealized slider bearing with a pivoted shoe- load carrying capacity, frictional resistance, coefficient of friction, location of the pivot point of a slider bearing with a pivot shoe. Numerical problems. **10 Hrs**

UNIT-V

Hydrodynamic Journal Bearing: Idealized journal bearings- infinitely long-full journal bearing- oil film thickness, Sommerfeld substitution, pressure distribution (no derivation), load carrying capacity, Sommerfeld number, viscous friction, modified Sommerfeld solution. Infinitely short-full journal bearing- pressure distribution (no derivation), load capacity and friction force. Numerical problems on idealized hydrodynamic journal bearing.

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing. Numerical on hydrostatic lubrication. **12 Hrs**

Text Books

1. Basu S K., Sengupta S N., Ahuja B. B., Fundamentals of Tribiology, PHI, 1st edition, 2009, ISBN: 978-8120327238
2. B. C. Mujumdar, Introduction to Tribiology of bearings, S.Chand (G/L) & Company Ltd,

2nd edition, 2010, ISBN: 978-8121929875.
3. E. I. Redzimovskay, Lubrication of bearings theoretical principles and design, The Ronald Press Company, 1st edition, 1959, ASIN: B0000EGL66.

Reference Books

1. Dudley D. Fuller, Theory and Practice of Lubrication for Engineers, John Wiley & Sons; 2nd Edition, 12 September 1984, ISBN: 978-0471047032.
2. Desmond F. Moore, Principles and Applications of Tribiology, Pergamaon Press, 1st edition, 1975, ISBN: 9780080179025.
3. Sushil Kumar Srivastava, Tribiology in Industries, S Chand and Company limited, India, 2004, ISBN: 9788121920452.
4. Prasanta Sahoo, Engineering tribology, PHI, 2005, ISBN: 978-8120327245.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Explain** friction, laws of friction and different types of wear in materials undergoing relative motion. **Characterize** surface texture and **determine** roughness characteristics using its measuring techniques.
2. **Explain** the properties of lubricants and classify them. **Derive** Hagen-Poiseuille law.
3. **Explain** the concept of lightly loaded bearings and **derive** Petroff's equation.
4. **Derive** expressions for pressure distribution, load carrying capacity, coefficient of friction, frictional resistance in a idealized slider bearing.
5. **Derive** expressions for pressure distribution, load carrying capacity and oil flow through the hydrodynamic journal bearing and hydrostatic step bearing.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Explain** friction, laws of friction and different types of wear in materials undergoing relative motion. **Characterize** surface texture and **determine** roughness characteristics using its measuring techniques.	**3**	**3**	**2**	**3**	**2**	**1**	**1**						**-**	**1**
CO2	**Explain** the properties of lubricants and classify them. **Derive** Hagen-Poiseuille law.	**3**	**3**	**2**			**1**							**-**	**1**
CO3	**Explain** the concept of lightly loaded bearings and **derive** Petroff's equation.	**3**	**3**	**3**										**-**	**1**
CO4	**Derive** expressions for pressure distribution, load carrying capacity, coefficient of friction, frictional resistance in a idealized slider bearing.	**3**	**3**	**1**										**-**	**1**
CO5	**Derive** expressions for pressure distribution, load carrying capacity and oil flow through the hydrodynamic journal bearing and hydrostatic step bearing.	**3**	**3**	**1**										**-**	**1**

Course Title: Industrial Robotics and Automation (Open Elective-II)			
Course Code**: P15ME841**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives:

- To familiarize students with brief history of robot and basic concepts of industrial robot.
- To expose the students to kinematics of robots and programming of robot
- To make the students familiar with various applications in robots in industry

Course Content

UNIT-I

INTRODUCTION: Automation and robotics, brief history of robotics, Robot Anatomy, Joints and Links, wrist and its motions, Classifications of robots, Robot Control Systems, Geometrical configuration, Work Volume, Pay load, Stability, Resolution, Accuracy and Repeatability. **10 Hrs**

UNIT-II

STRUCTURE OF ROBOTIC SYSTEM: End Effectors: types of grippers, tools. Robot drive system: Hydraulic, electric and pneumatic, Types of Actuators. Feedback components: position, velocity sensors, internal State sensors, tactile sensors, - proximity sensing, range sensing, force-torque sensors. **10 Hrs**

UNIT-III

ROBOT ARM KINEMATICS: Introduction to Kinematics, direct and inverse Kinematics, rotation Matrix, composite rotation matrix, rotation matrix about an arbitrary axis, Euler angles representation, homogeneous transformations, D-H representation of 3- axis robot. **10 Hrs**

UNIT-IV

ROBOT PROGRAMMING: Introduction, manual teaching, lead through teaching, Robot programming languages: Generations of robot programming Languages. Robot language elements and functions, Motion commands, simple programs. **10 Hrs**

UNIT-V

ROBOTS IN MANUFACTURING AUTOMATION: Material Transfer: general considerations in robot material handling: pick and place, palletizing operations. Machine loading and unloading: Die casting, Plastic moulding, Forging, machining and stamping press operations. Processing Operations: features of spot and arc welding robot, spray coating and other processing applications. **12 Hrs**

Text Books

1. Michell Grover, Mitchel weiss, Roger nagel **"Industrial Robots",** McGraw Hill 2012,India ,2ND edition, ISBN-13:9780070265097
2. Yoramn Koren, **"Robotics for Engineers"** Mc Graw hill Intl. Book Co., New Delhi 1987 ISBN-13:9780070353992

Reference Books

1. Robert J. Schilling, **"Fundamentals of Robotics"** PHI**, 1ST** edition-.2011, ISBN-13:9788120310476
3. K.S. Fu, R.C. Gonzales and Lee, **"Robotics"**. McGraw Hill Intl. India, 1ST edition, 2008 ISBN-13:9780070265103
2. Richard D. Klafter,C Thomas A, "**Robotic Engineering"** PHI,1993, ISBN-13:9788120308428
3. R.K. Mittal and J. Nagarath, **"Robotics and Control"** Tata Mc Graw Hill, DELHI,6TH edition 2007, ISBN:0070482934

Course Outcomes

After learning all the units of the course, the student is able to;

1. Analyze work volume, resolution, and accuracy of various configuration of robots
2. Identify different types of end effectors and sensors required for specific applications
3. Calculate the forward kinematics of robots using DH method
4. Develop robot task program using robot language
5. Discuss requirements of robot systems for various industrial applications.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Analyze** work volume, resolution, and accuracy of various configuration of robots	**2**	**2**	**1**	**1**									**-**	**1**
CO2	**Calculate** the forward kinematics of robots using DH method	**2**	**2**	**1**	**1**									**-**	**-**
CO3	**Identify** different types of end effectors and sensors required for specific applications										**1**		**1**	**-**	**1**
CO4	**Develop** robot program using robot languages					**2**					**1**		**1**	**-**	
CO5	**Discuss** various applications of industrial robot systems.					**1**					**2**		**2**	**-**	**1**

Course Title: Additive Manufacturing Process (Open Elective-II)

Course Code**: P15ME842**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: This course exposes students to latest additive manufacturing processes used to produce prototypes, parts and tools.

Course Content

UNIT-I

INTRODUCTION: Need for the compression in product development, Prototypes, history of AM systems and classification of AM systems, basic steps in AM, advantages and disadvantages of AM process.

LIQUID BASED AM PROCESS: Stereo lithography Systems**:** Principle, process details, merits and demerits, Applications. Solid Ground Curing**:** Principle of operation, process parameters, merits and demerits, Applications. **12Hrs**

UNIT-II

POWDER BASED AM PROCESSES**:** Selective Laser Sintering, Principle of operation, process parameters, merits and demerits, Applications. Laser Engineered Net Shaping: Principle of operation, process details, merits and demerits, applications.

SOLID BASED AM PROCESSES**:** Laminated Object Manufacturing: Principle of operation, materials, process parameters, merits and demerits, application. Fusion Deposition Modelling: Principle, Process parameter, merits and demerits, Applications. **10Hrs**

UNIT-III

CONCEPTS MODELERS: Principle, types, difference between AM machine and Concept

modeler, Thermal jet printer, Sander's model maker, 3- D printer. Genisys Xs printer, JP system 5, Object Quadra systems. **10Hrs**

UNIT-IV

RAPID TOOLING: Classification of Rapid tools, Indirect Rapid tooling: -Silicone rubber tooling, Spray metal tooling, 3D Keltool. Direct Rapid Tooling: Direct AIM, PRO Metal, DTM Rapid Tool. **10Hrs**

UNIT-V

APPLICATIONS OF ADDITIVE MANUFACTURING: Medical field. Automotive Industry, Aeronautical Industry, Construction Industry. **10Hrs**

Text Books

1. Paul F.Jacobs, "**Stereo lithography and other RP & M Technologies"** -SME, NY 1995.ISBN-13:9780872634671
2. Pham D.T & Dimov, S.S Verlog, "**Rapid Manufacturing"** springer, London 9 November 2011, ISBN-13:9781447111825

Reference Books

1. I.Gibson, D. W. Rosen, B. Stucker, "Additive Manufacturing Technologies" ISBN: 978-1-4419-1119-3, e-ISBN: 978-1-4419-1120-9 Springer New York
2. Wohlers, Terry T, "Rapid Prototyping" Wohler's Report 2000, Wohler's Association 2000. **Wohlers Report 2015**, 314-page publication, Wohlers Associates, Inc., April 2015
3. Lamont wood, "Rapid automated" Industrial press, New York, August 1, 1993, ISBN-13: 9780831130473

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Identify** Classification of AM systems.
2. **Describe** working principle and applications of major AM systems
3. **Distinguish** AM Machine and Concept Modelers
4. **Explain** different types of Direct rapid tooling
5. **Identify** different types of Indirect rapid tooling

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** AM systems based on raw materials used.	**2**	**1**	**1**									**1**	**-**	**1**
CO2	**Compare** various AM process	**2**	**1**	**1**										**-**	**-**
CO3	**Distinguish** between AM machines and concept modelers.	**2**	**1**	**1**										**-**	**-**
CO4	**Explain** Applications of AM in various fields	**2**	**1**	**1**									**1**	**-**	**1**
CO5	**Distinguish** Direct and Indirect rapid tool	**2**	**1**	**1**									**1**	**-**	**1**

Course Title: Power Plant Engineering (Open Elective-II)			
Course Code**: P15ME843**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: the course is helps the student to understand about power plants and its working and the student must able understand the importance of renewable sources.

Course Content

UNIT-I

A BRIEF ACCOUNT OF HARNESSING ENERGY: From sources such as fuels, flowing water, wind, ocean, tides and waves, geothermal and nuclear energy. A brief description of thermionic, thermoelectric and fuel cell energy conversion devices. Choice of site for power station: load estimation; use factor diversity factor and demand factors. **10 Hrs**

UNIT-II

HYDROELECTRIC AND THERMAL POWER PLANT: Hydrometric survey, rainfall, catchment area, runoff, storage and pondage; flow duration and mass curves, hydrographs. Classification of hydroelectric plants. General arrangement of a hydroelectric plant and its operation. Developing trends in thermal coal in lump form stokers; different types of stokers, equipment for preparation and burning of pulverized coal unit system and bin system. **11 Hrs**

UNIT-III

GENERATION OF STEAM: A brief account of Lamont and Benson steam generators.
STEAM GENERATOR ACCESSORIES: Super-heaters and re-heaters. Different types of cooling towers, Coal and ash handling - different types of coal storage and coal conveyors, pneumatic and hydraulic methods of ash handling systems. **11 Hrs**

UNIT-IV

DIESEL ENGINE PLANT-Engines for power generation, Method of starting diesel engines, Cooling and lubrication system for the dieselengine. Filters, centrifuges, Oil heaters, intake and exhaust system. Gas turbine power plant: Advantages and disadvantagesof the gas turbine plant Open and closed cycle turbine plants with theaccessories. **10 Hrs**

UNIT-V

NUCLEAR ENERGY: Fusion and fission reaction; elements of a nuclear reactor-moderator, control rod, fuel rods coolant. Nuclear fuels.
REACTORS: Pressurized water reactor, Boiling water reactor and Gas cooled reactor. Radiation hazards; shielding, and radioactive waste disposal. **10 Hrs**

Text Books

1. Arora& S Domkundwar, AV Domkundwar, "A course in Power Plant Engineering", Dhanpatrai& co. Pvt.ltd.2014, ISBN:9788177001075
2. P. K. Nag, "Power Plant Engineering" Tata McGraw Hill, INDIA 4TH edition. 2014, ISBN:9789339204044
3. F.T. Morse, "Power Plant Engineering", G. Van Nostrand. 3rd edition 1953, ISBN:9780442055561

Reference Books

1. Barrows,Water power Engineering, TMH, New Delhi, 3rd edition, 1998
2. Stanierr,Plant Engineering, Hand Book, McGraw Hill. 1998
3. JagadishLal, "Hydraulic Machines" Metropollitan Book Co. Pvt Ltd., 1994.ISBN: 978-8120000261

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Discuss** energy sources such as fuels, flowing water, wind, ocean, tides, waves, geochemical, nuclear energy and **Calculate** load estimation, use factor and demand factor.
2. **Characterize** the working principle of Hydroelectricpower plant and **Describe** different

types of stokers and oil burners in thermal power plant.

3. **Discuss**generation of steam by using high pressure boilers and **Calculate**height and efficiency ofChimney.
4. **Discuss**Steam Generator Accessories, Method of starting Diesel Engine to generate power, Cooling and Lubrication System and Layout of diesel Power plant.
5. **Recognize** the Principles of Nuclear Energy and **Describe** different types of nuclear Reactors.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Explain** energy sources such as fuels, flowing water, wind, ocean, tides, waves, geochemical, nuclear energy and **Analyze** the load estimation, use factor and demand factor.	**3**	**3**											-	-
CO2	**Summarize**the working principle of Hydroelectricpower plant and different types of stokers and oil burners in thermal power plant.			**2**										-	-
CO3	**Explain**generation of steam by using high pressure boilers and **solve height**and efficiency ofChimney.	**3**	**3**										**1**	-	-
CO4	**Explain**Steam Generator Accessories, Method of starting Diesel Engine to generate power, Cooling and Lubrication System and Layout of diesel Power plant.	**3**		**1**										-	-
CO5	**Define** the Principles of Release in Nuclear Energy and **Explain**different types of nuclear Reactors.		**1**				**1**							-	-

Course Title: Maintenance Engineering			
Course Code**: P17ME844**	Semester: VIII	L-T-P-H: 4-0-0-4	Credits: 03
Contact Period - Lecture: 52 Hrs. ; Exam:3Hrs.		Weightage: CIE: 50 %;	SEE: 50%

Course Objectives: The course aims at strengthening the Maintenance and management capabilities of the students by exposing them to handling the different maintenance requirements and management that are commonly used in Machinery.

Course Content

UNIT-I

Introduction to Maintenance System: Definition, Scope, Objective, Functions and Importance of maintenance system.

Types of Maintenance System: Break down maintenance system, Preventive maintenance, Predictive maintenance design out maintenance, corrective maintenance, Planned maintenance, total productive maintenance, condition monitoring. Problems on selection of methods like preventive or breakdown maintenance. **12Hrs**

UNIT-II

Economics in Maintenance: Repair, replacement, Repair complexity, Finding out most optimal preventive maintenance frequency. Numerical treatment required.

Machinery Maintenance: Causes of machine failure, performance evaluation, complete overhauling of Machines tools. **10Hrs**

UNIT-III

Maintenance Planning: Maintenance planning and scheduling. Repair order control manpower requirement, Maintenance job analysis spare parts control.

Maintenance Scheduling: Planning of maintenance junctures man power allocation, Long range planning, short range planning. Planning techniques and procedure. Estimation of maintenance work. Maintenance control. **10Hrs**

UNIT-IV

Computers in Maintenance: Features and benefits of Computer aided maintenance. Application of computer to maintenance work.

Pollution Control in Industry: Dust control- Fiber collectors, mechanical dust collectors, wet type collectors, Electro static precipitators, Noise pollution Control –Noise measurement and control. Industrial vibration and its control. **10Hrs**

UNIT-V

Industrial Safety: Economic importance of accidents, types of safety organizations, analysis of accident records, accident investigations. Analysis of accident Safety standards for Mechanical equipment and Electrical system. Chemical hazards, material handling, exhaust system, welding, plant housekeeping-building, Aisles, Passages, floors, tool cribs, washrooms, canteens. **10Hrs**

Text Books

1 R. C. Mishra and K Pathak, **"Maintenance Engineering and Management,"** PHI Learing Pvt. Ltd., 2nd edition , 2012, ISBN: 9788120345737.
2 Morrow L C, **"Maintenance Engineering Hand book,"** McGraw-Hill Inc., US;2nd revised edition, 1967, ISBN: 9780070432017.

Reference Books

1 Frank Herbaty, **"Hand book of Maintenance Management,"** Noyes Publication, 2nd edition, 1990, ISBN: 9780815512042.
2 W.Grant Ireson, Eugene L. Grant, **"Hand book of Industrial Engg & Management,"** 2000.
3 Herbert F. Lund, **"Industrial Pollution Control Handbook,"** McGraw-Hill Publication, 1st edition, 1971, ISBN: 9780070390959.
4 H P Garg, **"Industrial Maintenance,"** S Chand & Co Ltd., 3rd edition, 1987, ISBN: 9788121901680.

5 Keith Mobley, Lindrey Higgins, Darrin Wikoff, "**Maintenance engineering Hand book,"** McGraw Hill, 7th edition, 2008, ISBN: 9780071546461.
6 William Staniar, **"Plant engineering hand book,"** McGraw-Hill Publication,1st **edition**,1950, Digitized 2007.

Course Outcomes

After learning all the units of the course, the student is able to;

1. **Distinguish** maintenance system types, scope, objective, functions and importance.
2. **Recognize** causes of machine failure, performance evaluation and overhauling.
3. **Evaluate** overhauling, maintenance planning, scheduling, estimation and maintenance control.
4. **Analyse** benefits and application of computer aided maintenance, and pollution control.
5. **Analyse** accident records, accident investigations, industrial and accident safety.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Distinguish** maintenance system types, scope, objective, functions and importance.	**3**	**1**											**-**	**2**
CO2	**Recognize** causes of machine failure, performance evaluation and overhauling.	**3**	**3**								**1**		**1**	**-**	**3**
CO3	**Evaluate** overhauling, maintenance planning, scheduling, estimation and maintenance control.	**3**	**2**				**1**	**1**			**1**		**2**	**-**	**3**
CO4	**Analyse** benefits and application of computer aided maintenance, and pollution control.	**3**	**1**	**1**			**2**	**2**					**2**	**-**	**3**
CO5	**Analyse** accident records, accident investigations, industrial and accident safety.	**3**	**1**	**2**			**3**				**1**		**2**	**-**	**3**