M.E.5.1 Machine Design-I

Course Objective:

- To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
- To illustrate to students the variety of mechanical components available, their design and emphasize the need to continue learning.

Instructional Objective: Help the students to apply the knowledge of Engineering Mechanics, Mechanics of solids and Engineering Materials science in the design of machine components.

Lecturer per week	: 3 hour
Practicals per week	: 2 hour
Max. marks for theory paper	: 100
Max. marks for sessionals	: 25
Duration of the paper	: 3 hour
Total no of modules	: 4
No. of question from each module	: 2
Total no of question to be answered	: 5 (at least one question from each module)

Module-I (2+3+3+4)

1. BASIC CONCEPTS: Meaning of design with special reference to machine design. Definition and understanding of various types of design, Elaborated Design process

2. GENERAL DESIGN CONSIDERATIONS

.Concept of tearing, bearing, shearing, crushing, bending etc. Selection of materials, Basic criteria of selection of material, their designation, mechanical properties of those materials in brief. Study of Stress concentration, factor of safety under different loading conditions,

3.SIMPLE PART DESIGN

Design for static loading, design for variable loading for both limited and unlimited life, concept of fatigue and endurance strength.

4. DESIGN OF FLEXIBLE MEMBERS: Design of Flat belt, V-belt and rope (steel wire), Design of the pulley for the same. Selection of Chain Drive

Module-II (4+4+2+2)

6. DESIGN OF FASTERNERS

6.1.RIVETS: Design of rivets for boiler joints, lozenge joints (uniform strength joint), eccentrically loaded riveted joints

6.2.BOLTS: Understanding the various stresses/ failure in bolted joints, design of cylindrical covers, basic and eccentrically loaded bolts

6.3.WELDS: Design for various loading conditions in torsion, shear or direct load, eccentrically loaded welded joints.

6.4.MISCELLENEOUS: Design of spigot and socket cotter joint, Gib and Cotter joint and knuckle joint.

Module-III (6+3)

7. DESIGN OF TRANSMISSION SHAFT

Design of both solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for critically speed, Design of shaft for rigidity and Design of stepped shafts for assembly

8. DESIGN OF KEYS AND COUPLINGS:

Design of sunk keys under crushing and shearing, design of splines, design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling.

Module-IV (6+4)

9. MECHANICAL SPRINGS:

9.1 Stresses and deflections of helical springs – Extension -compression springs – Springs for fatigue loading. Natural frequency of helical springs – Energy storage capacity – helical torsion springs – Co-axial springs,

9.2 Design of Leaf springs, Belleville springs, Rubber springs.

Text books

1. Bhandari V.B.: Design of machine elements , Tata McGraw Hill
2. Khurmi R.S. Machine Design S.Chand and Co.
3. Sharma P.C. & Aggarwal D.K. Machine Design , Kataria & sons.

References:

1. Shigley J.E., Mischke C.R.: Mechanical Engineering Design, McGraw Hill International.
2. Spotts M.F. Shoup T.E. Design of machine elements, Prentice-Hall International.
3. Hamrock B.J, Jacobson, Schmid S.R.: Fundamentals of machine elements McGraw Hill International.
4. Black & Adams: Machine Design, McGrawHill International.

Prescribed Design Data Hand Book: PSG Design Data Hand Book.

M.E. 5.2 Engineering Economics and Management

Course objectives: The objective of the course is to produce graduates who combine a sound knowledge of engineering with an understanding of the principles of manangement and economics.

Instructional Objectives:

- Understand the major capabilities of economics such as GDP, GNP etc.
- Be able to recognize, formulate, and analyze cash flow models in practical situations. Understand the assumptions underlying these models such as discounted cash flow calculations, including present-worth and rate-of-return calculations, financial analyses, accounting and depreciation capital budgeting, etc., and the effects on the modeling process when these assumptions do not hold.
- Be able to understand management concepts such as planning, organising, staffing, leading and control..

Lectures per week	: 03
Tutorials per week	:01
Max. marks for theory paper	: 100
Max mks for practicals	: 0
Max. mks for sessionals	: 25
Duration of paper	: 3 hours
Total no of modules	: 4
No of questions from each module	: 2
Total no of questions to be answered	: 5

Module 1

No. of hours: 17

General Economics

Demand and supply analysis, Demand and Supply curves, Market equilibrium
National Income terms – GDP, GNP, NDP, NNP, Methods of calculating national income
Price index, Inflation
Estimation/Forecasting of demand
Economies and Diseconomies of scale
Mergers, Takeovers and Acquisitions

Module 2

No. of hours: 15

Accounting and Capital Budgeting

Environment of Finance
Forms of Business
Regulatory framework

Taxes
The financial system
Preparation of income statement, Balance sheet, Fund flow statement, Ratio analysis – Liquidity, Leverage and Profitability ratios
Working Capital management– Determinants of wkg. cap., Financing of wkg. cap., Dangers of excess and scarce wkg. cap.
Depreciation – Causes, Methods - Straight line method, Declining balance method, Sum of years digits method, Sinking fund method
Capital Budgeting – Process, need and importance, Methods of project evaluation – Payback period, Accounting rate of return, Internal Rate of return, Net Present Value,
Sources of long-term finance
Retained earnings
Equity capital
Preference capital
Debenture capital
Term loans

Module 3

No. of hours: 10

General Principles of Management

Introduction to Management, Functions of a manager, Different schools of management – Scientific, Modern Operational and Behavioural
Nature of Objectives
MBO
Process
How to set objectives
Benefits and Weaknesses
Organisation
Formal and Informal Organisation
Organisational levels and the Span of management
Factors determining an effective span

Organisation structure : Departmentation
Departmentation by
Simple numbers
Time/Enterprise function
Territory
Customer
Process
Product

Matrix Organisation
Strategic Business Unit

Decentralisation and Delegation
Factors determining the degree of decentralization

Module 4

No. of hours: 13

Managing People

Motivation
Carrot and stick theory

Maslow's hierarchy of needs theory
Herzberg's motivation-hygiene theory,
Vroom's Expectancy theory,
McClelland's needs theory,
Theory X, Theory Y

Leadership
Ingredients of leadership
Trait theory
Behavioural theory
Contingency theory

Human Resource Management and Selection
Defn. of Staffing
Overview of the staffing function
Selection process, techniques and instruments
Recruitment and selection, Appraisal methods

Communication
Communication function in organizations
Basic communication process
Communication in an organisation
Barriers in communication
Principles of effective communication

Controlling
Basic control process
Critical control points and standards
Types of controls
Requirements for effective controls

Textbooks :

1. R.L. Varshney and K.L. Maheshwari, *Managerial Economics* Sultan Chand and Sons, 1994
2. Harold Koontz and Heinz Weihrich, *Management, A global perspective* 10th Edition McGraw Hill, 1994

References :

1. Petersen and Lewis, *Managerial Economics*, PHI
2. Prassanna Chandra, *Fundamentals of Financial Management* 3rd Edition Tata McGraw Hill, 2001
3. Richard Lynch and Robert Williamson *Accounting for Management*, *Planning and Control* 3rd edition, Tata McGraw Hill

M.E. 5.3 HEAT AND MASS TRANSFER

Course Objective: Understanding the physics of heat transfer phenomena helps gain insights about nature, refrigeration & air-conditioning, energy production and processing, manufacturing & materials processing. Knowledge in heat transfer helps to optimize processes and gain production, energy and cost efficiencies.

Instructional Objective: Heat transfer studies enables us to:

- Understand how heat is transferred (the modes)
- Calculate the rate at which heat is transferred
- Estimate the temperature distribution within a body experiencing heat transfer

No. of Lectures per week:	:3
Number of tutorials per week:	:1
Max. marks for theory paper	:100
Max. marks for sessionals	:25
Duration of paper	:3 hours
Total no of modules	:4
No of questions from each module	:2
Total no of questions to be answered	:5

MODULE I

Introduction Applications of heat transfer in engineering field. Modes of heat transfer, Fourier's law of heat conduction, Newton's law of cooling, Stefan-Boltzmann's law of radiation. Significance of thermal conductivity. Variation in thermal conductivity with temperature.

(03 Hours)

Conduction: Three dimensional heat conduction equation in Cartesian coordinate for anisotropic material for unsteady state condition, thermal diffusivity and reduction to Fourier equation, Laplace equation and Poisson's equation. One dimensional steady state heat conduction through a plane wall, cylindrical wall and sphere, Analogy between Heat flow and electricity, heat conduction through a composite slab, cylinder and sphere, overall heat transfer coefficient, Critical radius of insulation, thermal contact resistance and economic thickness of insulation. Concept of thermal resistance and conductance.

(04 Hours)

One dimensional steady state heat conduction with heat generation:-
Conduction heat transfer through plane wall, solid cylinder, hollow cylinder and sphere with heat generation. Practical problems involving heat generation.

(03 Hours)

MODULE II

Extended Surfaces

Heat transfer through extended surfaces. Fins of different shapes. Derivation of differential equation for fins with constant cross section with different boundary conditions. Effectiveness and efficiency of a fin. Error in the measurement of temperature in a thermo-well. Heat sinks- types and applications.

(03 Hours)

Transient Heat Conduction:

Approximate solutions, Analytical solutions. System with negligible internal resistance. Biot and Fourier numbers. Criteria for neglecting internal temperature gradient. Heisler charts.

(03 hours)

Heat Exchangers

Classification of Heat exchangers, Overall heat transfer coefficient, Fouling factor, the LMTD Method for Heat exchanger analysis, Correction factors for cross-flow and multipass flow, the Effectiveness-NTU method for Heat exchanger analysis.

(04 Hours)

MODULE III

Convection

Mechanism of convection, Classification of convection, Introduction to hydrodynamic and thermal boundary layer. Laminar and turbulent flow over and inside a surface.

Dimensional analysis of free and forced convection. Physical significance of the dimensionless parameters – Nusselt number, Reynolds number, Prandtl number, Grashoff number, Stanton number, Rayleigh number, Peclet number & Graetz number

(04 Hours)

Natural convection:

Physical mechanism, Definitions, Empirical correlation's for free convection heat transfer over horizontal plate, vertical plate and cylinder.

(03 Hours)

Forced convection:

Empirical correlation's for heat transfer in laminar and turbulent flow over a flat plate across cylinders and in a circular pipe. Concept of hydraulic diameter.

(03 Hours)

MODULE IV

Thermal Radiation

Fundamental concepts, Spectrum of electromagnetic radiation, Black bodies radiation, Theories of Radiation and Black body radiation laws (Kirchoff's law, Planck's distribution law, Wien's displacement law and Stefan Boltzmann's law). Surface emission, radiative properties of a surface. Grey, black, white and real surface. Solid angle, intensity of radiation, Lambert's cosine law.

(04 Hours)

Radiation exchange between surfaces

Heat exchange by radiation between two finite black surfaces. Radiation shape factor, use of shape factor charts. Irradiation, radiosity, electrical network method of solving problems. Heat exchange between non-black bodies and Heat exchange between two infinitely parallel planes, cylinders and spheres. Radiation shields, Gas radiation, and solar radiation. **(03 Hours)**

Mass Transfer

Introduction to Mass transfer, Modes of Mass Transfer, Fick's law of diffusion, General mass diffusion equation in stationary media, Steady state diffusion through a plain membrane, Steady state equimolar counter diffusion, Diffusion in Gases, liquids and solids, The mass-transfer coefficient, Evaporation process in the atmosphere , Mass convection. **(03 Hours)**

Text Books

1. P.K. Nag, "Heat Transfer" : Tata McGraw Hill
2. Thirumaleshwar, "Heat Transfer", Pearson Education
3. C.P. Kothandraman, " Fundamentals of Heat and Mass Transfer" New Age International Publishers.

References :

1. Ozisik N.M: "Heat transfer – A basic approach", McGraw-Hill
2. Holman J.P: "Heat Transfer", McGraw-Hill
3. Taine & Petit: "Heat Transfer" : Prentice Hall
4. Yunus A. Cengel : "Heat transfer – A Practical Approach" : McGraw Hill
5. J.P. Holman, "Heat Transfer", McGraw hill
6. Frank P Incropera, David P De Witt, , "Fundamentals of Heat Transfer", Wiley, Eastern Limited.
7. Sukhatme S. P.,"A text book on Heat Transfer" Orient Longmans Ltd.
8. "Heat and Mass Transfer Data Book" : C.P. Kothandraman , S. Subramanyan. New Age International Publishers.

M.E. 5.4 MANUFACTURING TECHNOLOGY II

Course overview: This course provides a comprehensive knowledge and insight into the machining techniques in a modern workshop. Beginning with the fundamentals of metal cutting and operations on the basic workshop machines, the course extends to cover the cutting tool materials, tool geometry, dynamometers and economics involved in a machining workshop. Due stress is also given to gear manufacturing and unconventional machining processes.

Instructional objectives: This course will enable the students to understand the following

- Basics of metal cutting and the operations performed on the commonly used workshop machines like lathe, milling, drilling, shaping, planning, broaching etc.
- Cutting tool geometry, tool material requirements and commonly used tool materials.
- Gear manufacturing and unconventional machining processes.

Lecture per week	**3 hours**
Tutorials per week	**1 hour**
Max marks for theory paper	**100**
Max marks for sessionals	**25**
Total no. of modules	**4**
Total no of questions to be answered	**5 (At least one question from each module)**

MODULE I

Theory of metal cutting Wedge shaped tool and its features, orthogonal and oblique cutting, Chip formation and types of chips, built-up-edge, chip thickness ratio, velocity diagram, shear strain in metal cutting.

Concept of feed, speed, depth of cut and cutting forces in turning, milling, drilling and grinding. Effect of various parameters on cutting forces

Effect of different parameters on surface finish. Expression for the height of feed ridges.

Merchants Theory and its modification– Expression for shear plane angle

MODULE II

Cutting Tool Materials - Basic requirements, selection, study of high carbon steel, high speed steel, cemented carbides, coated tools, ceramics and diamonds

Tool life and tool wear –Definitions, symptoms of end of tool life, tool life equations, tool wear mechanisms, wear types, tool life criteria. Effect of built-up-edge and tool angles on tool life.

Single point cutting tool geometry - Definitions and significance of various angles in plan view and in different sections. Relationship between these angles.

MODULE III

Machining operations - Basic operations performed on lathe, milling, grinding, broaching, shaping, and planning.

Economic of machining - Introduction, machining time and associated cost, criteria for feed choice, expressions for optimum cutting velocity under different criteria, restrictions for feed choice

Machinability - Measures, different criteria for assessing machinability, machinability ratings.

Cutting fluids - Objectives, requirements, classification, selection of cutting fluids.

Dynamometers – Introduction, requirements, dynamometers for turning, milling, drilling and grinding operations.

MODULE IV

Unconventional Machining – Introduction and necessity. Ultrasonic Machining, electric discharge machining, electrochemical machining, abrasive jet machining, laser beam machining, electron beam machining

Gear Manufacturing - Gear cutting processes - Gear hobbing, Gear shaping, Gear lapping, Gear grinding and Gear broaching.

Text Books

1. Rao P. N., *Metal Cutting*, Tata Mc Graw Hill
2. Lal G. K., *Manufacturing Science*, Narosa publishing house

References

1. Juneja B. L. & Sekhon G. S., *Fundamentals of metal machining and machine tools*, Wiley Eastern Ltd
2. Trent E. M., *Metal Cutting*, Butterworths
3. Amitabh Ghosh & Mallik A.K., *Manufacturing science*. EWP
4. Shaw.M.C., *Metal cutting principles* , CBS Publishers and distributors
5. Production Technology –HMT
6. E. Paul DeGarmo, J.T Black, Ronald A. Kohser, *Materials and Processes in manufacturing*, PHI

M.E.5.5 Theory of Machines-II

Course Overview

This course aims it providing basics of Dynamics of Machinery. Emphasis on basic principles and there applications to various mechanical systems.

Instructional Objective:

After completion of the course, students will be in position to carry out dynamic analysis of the mechanical systems. They will also appreciate the need for vibration analysis in design engineering..

Lectures per week	: 03
Tutorials per week	:01
Max. marks for theory paper	: 100
Max. mks for sessionals	: 25
Duration of paper	: 3 hours
Total no of modules	: 4
No of questions from each module	: 2
Total no of questions to be answered	: 5

MODULE I

No. of Hrs. 15

Static Force Analysis of Four-bar, Reciprocating Engine Mechanism, Spur Gears, Cam follower Mechanism.

Rigid Body Motion. Newton's and Euler's Equations. Balancing of Rotating Body, Gyroscopic Moment.

Dynamic force Analysis of Four-bar linkage.

Virtual work Principle as applied to Mechanisms.

MODULE II

No. of Hrs. 10

Dynamics of Reciprocating Engine Mechanism, inertia effect of Reciprocating mass and Connecting rod, T-θ diagram, Fluctuation of Energy and speed, Flywheel and Governors[1]

Balancing of Reciprocating masses, Multi-cylinder in-line Engines, V-engines. Opposed piston Engines, Partial Balancing of Locomotives and it's effect. (No Numerical on coupled Locomotives, only the concept and need for coupled Locomotives.)

[1]No numericals, emphasis on need of Flywheel and a Governor, their comparison, and necessary attributesof Governor Mechanism.

MODULE III

No. of Hrs. 15

Free vibration of Single Degree Freedom damped and undamped system. Periodic motion.

Forced Vibration of Single Degree Freedom system by harmonic forcing function, Excitation of the system by harmonic support motion, Principle of Vibration measuring

instruments. Vibration of Single Degree Freedom System by Rotating Unbalance, Vibration Isolation.

MODULE IV

No. of Hrs. 10

Whirling of shafts, critical speed.

Two degree of freedom system free vibration, Exact Analysis, natural frequencies and mode shapes.

Numerical methods for multi-degree freedom systems: Rayleigh's method, Dunkerley's method and Holzer's method.

Text books

1. Ambekar: Theory of Machines and Mechanisms, PHI
2. Grover: Mechanical Vibrations. S. Chand & Co.

References:

1. Shigley Uicker: Theory of Machines and Mechanisms, Mc Graw Hill.
2. Rao and Dukkipati: Theory of Mechanisms and Machines. New age International
3. Ghosh A. and Malik A.K.: Theory of Mechanisms and Machines, East west Publishers
4. Rao S.S. Mechanical Vibrations, Pearson Education.
5. Rao J.S., Gupta: Theory and Practice of Mechanical Vibrations, New Age International.
6. Mairovitch: Mechanical Vibrations, Mc Graw hill Int.

M.E. 5.6 Quality Engineering and Management

Course Objective: While living in the era of globalization where issues like six sigma in business process management are given the topmost priority, it becomes rather mandatory to learn various issues involved in quality. To analyze such issues the tool statistics is a must. This course primarily aims at to impart such knowledge to the pursuer so that he/she can understand the fundamental problems in quality and design ways to monitor them and methods to improve upon the process thereafter using the tool statistics.

Instructional Objective: The pursuer at the end of the course will be able to:

- Understand randomness in field and model it
- Collect and analyze data pertaining to quality issue
- Design and implement control chart in a typical manufacturing scenario
- Understand and adopt acceptance sampling plan in engineering field

Lectures per week	: 03
Tutorials per week	:00
Max. marks for theory paper	: 100
Max mks for practicals	: 0
Max. mks for sessionals	: 25
Duration of paper	: 3 hours
Total no of modules	: 4
No of questions from each module	: 2
Total no of questions to be answered	: 5

Module-1: Modeling Process Quality

(3+6+6)

1.1 Probability Preliminary: Definition, conditional events, total probability, Baye's theorem; Random variable- characteristics- mean, variance, distribution function, E and V- operators, moment generating function (MGF), function of one dimensional random variable, problems and solution procedure

1.2 Probability distributions:

1.2.1 Discrete distributions: Bernoulli trial, Binomial, Geometric, and Poisson- establishment, Mean, Variance and MGF derivations, application-memoryless property and reproductive property, numericals and solution procedure

1.2.2 Continuous distributions: Uniform, Exponential, and normal- establishment, mean, variance and MGF derivations, application-memoryless property, reproductive property, Central Limit Theorem, normal approximation to binomial, numericals and solution procedure

Module-2: Inference about Process Quality

(1+6+8)

2.1 Preliminary: Definitions, sampling distributions- Normal, Student t, Chi-square and F distributions (only structure and concepts without theorems and proofs)

2.2 Method and Measurement of Process Parameter:

2.2.1 Point estimation: Definition, properties-unbiased, efficient and consistent; Maximum likelihood estimation for point estimator.

2.2.2 Confidence interval estimation: Definition, confidence interval of single and double population on mean and difference in means, variance known and unknown, confidence interval on variance(s) of normal distribution of single and two populations-calculations and solution procedure

2.3 Tests of Hypotheses: Introduction, Type I and II errors, O.C curve, Statistical analysis- on test on mean and equality of two means of single and two populations, variance(s) known and unknown, on variance and variances of single and two normal population(s), choice of sample size, Test for Goodness of fit - discrete and continuous distributions mentioned in § 1.2 with working rule, Test for independence-concept, working rule, calculations and solution procedure

Module-3: Statistical Quality Control

(2+8+4+3)

3.1 Methods and philosophy: Introduction, Quality definition and brief history of evolution, methods and philosophy of statistical process control- assignable and chance causes, problem solving tools-histogram, Pareto chart, Cause and Effect diagram, scatter diagram (concepts only)

3.2 Statistical Process Control:

3.2.1 Control charts for variables: statistical basis, development and use of sample mean & range and sample mean and standard deviation charts, charts based on standard values, interpretation, analysis of pattern, Type I and II errors, Average Run Length (ARL), Average Time to Signal (ATS), selection of sample size, Operating-Characteristic (O.C) function, application, solution procedure, numericals and cases discussion.

3.2.2 Control charts for attributes: Control charts for non-conformings (p, np charts)-Statistical basis, development and operation, variable sample size, Type I and II errors O.C function and ARL calculations application, solution procedure, numericals and cases discussion.

Control charts for non-conformities (C, U charts)-Statistical basis, development and operation, variable sample size, Type I and II errors, O.C function, application, solution procedure, numericals and cases discussion

Module 4: Acceptance Sampling

(9+4)

4.1 By attributes: Single, double and Multiple sampling plans-calculation of Probability of acceptance, O.C Curve- sensitivity; MIL-STD (rejection plan) and Dodge-Romig system (rectification plan)-standard terminology and computation, referring standard

tables and calculations, design of single, double sampling plan, use of Cameron table-Dodge-Romig, single, double and multiple-MIL-STD system; sequential sampling plan-design and applicability

4.2 Principle of Statistical Process Improvement:

4.2.1 Process Capability Analysis: Natural Tolerance Limits, process dispersion, process capability Ratio -potential and actual, interpretation and use, application, solution procedure, numericals and cases discussion

4.2.2 Process Improvement: Concept of variance reduction, Introduction to six sigma management- evolution, sigma level, methodology and tools, implementation roles (Conceptual treatment only).

Text:

1. Montgomery D. C. (2001), Introduction to Statistical Quality Control, 4th edition, John Wiley & Sons, Inc., New York,
2. Grant E.L. and Leavenworth R.S.(2000), Statistical Quality Control, 7th Edition, McGraw-Hill publisher, New Delhi.
3. Montgomery D. C. Runger C. G. (1999), Applied statistics and probability for engineers, 2nd Edition, John-Wiley & Sons, Inc., New York,

References:

1. Johnson A. R. (1996), Probability and Statistics for engineers, Prentice Hall of India, New Delhi
2. Smith M. G. (2004), Statistical process control and Quality improvement, 5th Edition, Pearson Education, Delhi,
3. Zaidi (1997), SPC concepts, methodologies and tools, Prentice Hall of India, New Delhi
4. Juran G. M., Gryn M. F. (1995), Quality planning and analysis: from product development through use, 3rd Edition, Tata McGraw Hill, Pub., New Delhi.
5. Mitra A. (2002), Fundamentals of Quality Control and improvement, 2nd Edition, Pearson Education, Delhi.
6. Paranthaman D. (2000), Quality Control, Tata McGraw Hill, Pub., 11th Edition, New Delhi.

Me. 5.7 Practicals In Heat And Mass Transfer

Course Objectives:

- To understand the modes of heat transfer.
- To apply the basic laws of heat transfer.
- To gain insights into operational ranges, behavioural trends and shortcomings across different heat transfer equipments.

Instructional Objectives:

- Heat transfer analyses on various heat transfer setup using the basic laws .

No. of Hours per week :2 hours

Max marks for practicals :25

List of Experiments

1. To determine thermal conductivity of insulating material using Fourier's law of heat conduction.
2. To determine the effectiveness of a parallel flow heat exchanger using Logarithmic mean temperature difference.
3. To determine the effectiveness of a counter exchanger using Logarithmic mean temperature difference.
4. To determine the outlet temperatures of a parallel flow heat exchanger using ε- NTU method.
5. To determine the outlet temperatures of a counter flow heat exchanger using ε- NTU method.
6. To calculate the Stefan – Boltzmann's constant using the Stefan – Boltzmann's law of Radiation.
7. To determine the overall heat transfer coefficient of Pin-fin for Natural convection and determine the effectiveness of the Pin –fin.
8. To determine the overall heat transfer coefficient of Pin-fin for Forced Convection and determine the effectiveness of the Pin –fin.

M.E. 5.8 Practical in Manufacturing Technology II

Course overview: This course provides hands on experience to the students to work on the workshop machines like lathe, milling, drilling, shaping and planning.

Instructional objectives: This course will enable the students to have practical experience of the following operations:
Turning, facing, taper turning, thread cutting, knurling, drilling and gear cutting.

Practical per week	**2 hours**
Max marks for practical	**25**
Duration of practical examination	**2 hours**

Practicals:

I. Three machining jobs involving following operations:

- Plain Turning
- Facing
- Step turning,
- Taper turning,
- External and internal thread cutting,
- Knurling
- Eccentric
- Forming
- Drilling

Machining time calculation for each job.

II. One job on gear cutting operation.

M.E. 5.9 Practicals in Theory of machines II

Course Objective:

- To verify experimentally, the basic principles studied in the course work.
- To understand and implement experimental methods in Mechanical Engineering

Instructional Objectives:

Students to attain ability to:

- Design experiments keeping in mind the objective.
- Prepare and present the results along with relevant graphs.
- Draw conclusions, discuss results and ascertain the quantum and the sources of errors in the experiments.

Practical per week: 2 Hrs
Maximum mark for practical: 25
Duration of practical exam: 2Hrs

List of experiments:

This is representative list and leaves scope for designing new experiments relavant to the course. At least six experiments to be conducted and presented in journal.

1. Dynamic balancing of rotors on balancing machine.
2. Verification of gyroscopic rule.
3. To draw characteristic curve for Spring Controlled Governor.
4. To draw characteristic curve for Gravity Controlled Governor.
5. Determine mass moment of inertia of a given body using Tri-Filler suspension.
6. Determine damping ratio in a damped single degree freedom system.
7. Vibration measurement using Vibration Meter.
8. Vibration analysis using Vibration Meter and Filter.
9. Verification of Dunkerley's rule to determine natural frequency of multi degree freedom system.
10. To draw response of single degree freedom system to varying frequency of excitation on non-dimensional plane.

List of graphical work.

- Four sheets on Force Analysis.
- Two sheets on Balancing of rotating masses in several planes.
- One sheet on Synthesis of cam profile

5.10 Practicals in Quality Engineering Management

Teaching Schedule: P : 2 (hrs per week)
Scheme of Examination: Viva : 25 marks

Course Objective: to provide hands-on on data collection and analysis, setting up a control chart for a given process and therefore providing platform to improve manufacturing process

Instructional Objective: to provide a field exposure and involving them to understand and appreciate quality issues.

The following are the list of practical knowledge to be imparted:

- Simulate / collect field data and carryout data analysis
- Using EXCEL and/or any other valid software to analyze a simulated process on the following:
  - Construction of trial control chart
  - O.C function and analysis
  - Capability analysis
- Sequential sampling- a case discussion with acceptance and rejection lines
- Investigation on Multiple sampling Plan with a case and hence drawing O.C. curve
- Checking density function and probability law for the random variable listed in the theory course using a software
- Testing and analysis of hypothesis testing using a numeriacal/ case and hence drawing O.C curve with sensitivity

Other Requirements:

- The above investigations are to be reported in an appropriate and journal format journal
- As the practicals is more of software application, an standard manual encompassing all the features of a technical report

Pre-requisites:

- Set theory, descriptive statistics, software knowledge on EXCEL

M.E.6.1 INDUSTRIAL ENGINEERING

Course Overview: This course provides a comprehensive insight into the work study aspect of the jobs, wherein the method of doing a job is analyzed through diagrams and charts with an aim to find a better and safer method. Various procedures for timing a method are studied. Due emphasis is also laid on job evaluation and value engineering.

Instructional objectives: This course will enable the students to analyze the work content of the jobs, develop more efficient ways of doing a job and set time standards for the jobs.

Lectures per week **3 hours**

Tutorials per week **1 hour**

Max marks for theory paper **100**

Max marks for sessionals **25**

Total number of modules **4**

Total number of questions to be answered —5 (at least one question from each module)

Duration of Theory paper **3 hrs**

MODULE I

Productivity – Definition, measurement, scope. Partial and total productivity. Efficiency and effectiveness .Means of increasing productivity

Job Evaluation – Definition, objectives, procedure. Job description and Job specification Methods of job evaluation - ranking, job classification or grading, point system and factor comparison

Incentives – Definition, need, characteristics, types of incentives plans.

MODULE II

Work Study – Definition, objectives, procedure. Work content analysis. Work study as a means of improving productivity. Human factor in the application of work study.

Method Study – Definition, objectives, procedure. Selection of a job. Recording techniques - charts and diagrams [Charts-Outline, flow process, two handed, multiple activity and travel chart. Diagrams-Flow and string diagram]

Principles of motion economy. Use of human body, arrangement of the work place, design of tools & equipments

MODULE III

Work Measurement – Definition, objectives. Techniques of work measurement

- Time study - Definition, procedure. Job selection, elemental break up of job, performance rating , allowances, calculation of standard time
- Work sampling - Definition, procedure, determination of sample size.
- Standard data
- Predetermined motion time system

MODULE IV

Value Engineering – Concept, principle, methodology and scope.

T P M – Introduction, similarities and differences between T P M and T Q M, types of maintenance, T P M targes - O P E ,O E E, steps in introduction of T P M in an organization, organisation structure, pillars of T P M

Text Books

1. Introduction to work study by ILO
2. Kumar B., *Industrial Engineering*, Khanna publishers
3. Martand Telsang, *Industrial production management*, S. Chand

Reference

1. Ralph M. Barnes, *Motion and Time study. Design and measurement of work*, Wiley.
2. Benjamin W. Niebel, *Motion and Time study,* Mc Graw Hill
3. Benjamin Niebel and Andris Freivalds, *Methods , Standards and Work design,* Mc Graw Hill

M.E. 6.2 Machine Design-II

Course Objective:

- To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
- To illustrate to students the variety of mechanical components available and emphasize the need to continue learning.
- To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.

Instructional Objective: Help the students to apply the knowledge of Engineering Mechanics, Mechanics of solids and Engineering Materials science in the design of machine components.

Lecturer per week : 3 hour
Practicals per week : 2 hours
Max marks for Orals : 25
Max. marks for theory paper : 100
Max. marks for sessionals : 25
Duration of the paper : 3 hour
Total no of modules : 4
No. of question from each module : 2
Total no of question to be answered : 5 (at least one question from each module)

Module-I (5+3+5)

1.1 Design of Clutches: Torque transmitted by a clutch single plate, multi-plate, cone and Internal expanding clutches. Design of clutch plate, pressure plate, springs & lever. Introduction to one-way clutch.

1.2 Brakes: Braking torque. Block and band brake, internal expanding brake. Self locking and self energizing brakes. Limiting pressure, heating of brakes, disc brakes.

1.3 Machine Tool Elements: Elementary treatment on Design of beds, slide ways, spindles- material selection, design of strength and rigidity of parts.

Module-II (5+3)

2. BEARINGS:

2.1. Journal Bearings: Types of lubrication, viscosity Petroff's law, Stable lubrication, Thick-film lubrication, Introduction to hydrodynamic theory. Types of Journal bearings- Bearing Modulus – Full and partial bearings –Clearance ratio – Heat dissipation of bearings, bearing materials – journal bearing design

2.2 Ball and roller bearings – Static loading of ball & roller bearings, Bearing life.

Module-III (8+4)

3. Spur & Helical Gear Drives:

3.1 Spur gears- Helical gears – Load concentration factor – Dynamic load factor. Surface compressive strength – Bending strength – Design analysis of spur gears – Estimation of centre distance, module and face width, check for plastic deformation. Check for dynamic and wear considerations.

3.2 Worm gears: Force analysis, friction in worm gears, bending & wear strength of worm gears. Thermal consideration of worm gears. Selection of materials.

Module-IV (2+2+2+4)

4. Engine Parts

4.1Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends

4.2 Cranks and Crank shafts: strength and proportions of over hung and center cranks Crank pins, Crank shafts.

4.3 Pistons, Forces acting on piston: Construction Design and proportions of piston. Cylinder, Cylinder liners,

5. Design of power screws: Design of screw, Square ACME , Buttress screws, design of nut, compound screw, differential screw, ball screw- possible failures.

Text books

1. Bhandari V.B.: Design of machine elements , Tata McGraw Hill
2. Khurmi R.S. Machine Design S.Chand and Co.
3. Sharma P.C. & Aggarwal D.K. Machine Design , Kataria & sons.

References:

1. Shigley J.E., Mischke C.R.: Mechanical Engg. Design, McGraw Hill International.
2. Spotts M.F. Shoup T.E. Design of machine elements, Prentice-Hall International.
3. Hamrock B.J, Jacobson, Schmid S.R.: Fundamentals of machine elements McGraw Hill International.
4. Black & Adams: Machine Design, McGraw Hill International.

Prescribed Design Data Hand Book: PSG Design Data Hand Book.

Me 6.3 Gas Dynamics And Turbomachineries

Course Objective: Knowledge in gas dynamics helps to analyse compressible flow devices. Understanding the eulerian energy exchange using the velocity triangles helps the learner to understand the range of turbomachine equipment both power absorbing and power generating.

Instructional Objective: This course enables:

- Design and modeling of turbomachinery.
- Estimate the energy transfer and the various losses in equipment.
- Understand the compressible flow phenomenon.

Lectures per week :3
Tutorials per week :1
Max. marks for theory paper :100
Duration of paper :3 hours
Total no. of modules :4
Total no. of questions from each module :2
Total no. of questions to be answered : 5(At least on question from each module with two compulsory questions from any one module)

MODULE 1

PRINCIPLES OF TURBOMACHINERY: The turbomachine, Positive displacement machines and turbomachines, Static State, Concept of stagnation condition. Application of first and second laws to turbomachines, Efficiency of turbomachines.

ENERGY EXCHANGE IN TURBOMACHINES: The Euler turbine equation, Velocity triangles, Fluid energy changes, Impulse and reaction, Turbines- utilization factor, Specific speed.

CONSERVATION LAWS FOR COMPRESSIBLE FLOW: Conservation of mass and continuity equation, Conservation of momentum and momentum equation, Conservation of Energy and energy equation.

MODULE 2

CONCEPTS OF COMPRESSIBLE FLOW : Velocity of sound, Mach number and its significance, Various regions of flow, Physical difference between various flow regions, Kinetic form of steady flow energy equation, Reference speeds of compressible flow, Steam thrust and impulse function, Effect of compressibility on dynamic properties, Steady one dimensional compressible flow of perfect gas

ISENTROPIC FLOW: Governing equations, Effect of area variations, Reference states and isentropic flow relations, Supersonic nozzles, Differential equations governing flow with area change, Adiabatic flow.

MODULE 3

FLOW THROUGH NOZZLES AND DIFFUSERS: Operation of Nozzles under varying pressure ratio, under expansions and overexpansion in Nozzles, Losses in Nozzles, Supersaturated Flow of through steam nozzles, Performance of Diffusers.

STEAM TURBINES: Classification of Steam turbine, Impulse staging, Compounding of Steam turbines, Velocity diagram, Condition for maximum efficiency of Impulse Turbine, Most economical ratio of blade speed to steam speed for a two row velocity compounded wheel, Reaction turbine, Blade height in a reaction turbine, Losses in a steam turbine, Maximum gross stage efficiency of a 50% Parsons reaction turbine, Reheat factor.

MODULE 4

HYDRAULIC TURBINES: Hydraulic power utilization, Hydrograph and water power, Classification of water turbines, The Pelton wheel, Velocity triangles, Turbine efficiency and volumetric efficiency, Working proportions of Pelton wheels, Francis and Deriaz turbines, Velocity triangles and efficiencies, Design of Francis turbine, Propeller and Kaplan turbines. The draft tube

CENTRIFUGAL AND AXIAL- FLOW PUMPS: The centrifugal pump, Some definitions, Pump output and efficiencies, Multi-stage centrifugal pumps, Axial flow pump.

TEXT BOOKS :

1.SARKAR B.K. : Thermal Engineering , Tata McGraw Hill Publications

2. P. BALACHANDRAN. Fundamentals of Compressible Flow, Ist Edition, Prentice Hall of India, New Delhi, 2007.

REFERENCE BOOKS :

1. KADAMBI V. , MANOHAR PRASAD : An Introduction to Energy Conversion vol III, New Age International Publishers , New Delhi, 1997.

2. SOM S.K., BISWAS G. Introduction to fluid mechanics and fluid machines ,Tata McGraw Hill Publications.

3 YAHYA S.M: Fundamentals of compressible flow , New Age International Publishers

4. YAHYA S.M. :Turbines , Fans and Compressors, Tata McGraw Hill Publications

5. AJOY KUMAR, GN SAH. Thermal Engineering, Narosa Publications, New Delhi, 2004.

M.E.6.4 Engineering Measurements & Metrology

Course Objectives:
On completion of this subject a student should be able to:

- identify and appreciate the importance of standards
- relate geometric tolerances to dimensional errors
- differentiate between the various fundamental measurement approaches
- perform and interpret error analyses
- understand the components and requirements of measurement systems
- possess knowledge of the sources of measurement errors and how their influence may be reduced

Instructional objectives: Help the students to lean the principle, construction, operation and application of different measuring instruments used to measure different mechanical quantities.

Lecturer per week : 3 hour
Max. marks for theory paper : 100
Max. marks for sessionals : 25
Duration of the paper : 3 hour
Total no of modules : 4
No. of question from each module : 2
Total no of question to be answered : 5 (at least one question from each module)

Module-I (3+9)

1 **Introduction** : Uses of Measurement, Measurement of Length, Angle and Surface, Scope of Applied Metrology, Standardization.
1.1 Important Terms: Sensitivity, Magnification, Repeatability, Calibration, Readability, Reproduceability, Response Time.
1.2 Precision and Accuracy: Difference between Precision and Accuracy, Factors affecting accuracy of the measuring system, General rules for accurate measurement, Precautions to avoid inaccuracies during measurement.
1.3 Reliability. Comparison Terminology of Reliability, Precision and Accuracy.
1.4 Error : Definition of Error, Sources of Error, Classification of Error, Errors likely to creep in Precision measurement, Comparison between Systematic Error and Random Error, Other Types of Error and Analysis, Classification and Analysis of measurement error.
2. **Linear and Angular Measurement**
2.1 Linear measuring instruments: Vernier, micrometer, interval measurement, Slip gauges and classification, interferometery: optical flats,
2.2 Comparators: Mechanical, pneumatic and electrical types, applications.
2.3 Angular measurements:-Angle gauges, Sine bar, optical bevel protractor, angle Decker – Taper measurements.

Module-II (11)

3. **Limits, Fits and Tolerances**.

3.1 Interchangeability: Introduction, Advantages and Types

3.2 Limit Systems. Limit, fit, tolerances, tolerance built up, types of fits, selective assembly.

3.3 In brief earlier limit system (Nowall and BS 164) ISO/Indian Standard limit fit system

3.4 Selection of limit, geometrical tolerance. Limit gauging-Taylor's principle.

3.5 Geometric Dimensioning and Tolerancing: Introduction, Standard symbols and terminology, standard drawing, practice, and their interpretation.

Module-III (7+4)

4. **Form Measurement**

4.1 Measurement of screw threads-Thread gauges, floating carriage micrometer

4.2 measurement of gears-tooth thickness-constant chord and base tangent method-Gleason gear testing machine

4.3 Radius measurements-surface finish, straightness, flatness and roundness measurements.

5. **Laser and Advances in Metrology**

5.1 Precision instruments based on laser-Principles- laser interferometer-application in linear, angular measurements and machine tool metrology

5.2 Coordinate measuring machine (CMM)- Constructional features – types, applications digital devices- computer aided inspection.

5.3 Machine Vision applications in Metrology.

Module-IV (10)

6. **Measurement of Displacement, Force, Torque, Pressure, Temperature and Flow:**

6.1. Displacement measurement: Working principle of linear potentiometer, differential transformers, piezoelectric transducers, Hall effect transducers.

6.2. Force and torque measurement: The metallic resistant strain gauge, piezo electric load cell, eddy current dynamometers, strain gauges in rotating shafts.

6.3. Pressure measurements: Strain gauge pressure cell, Mc Leod gauge, calibration of pressure gauges.

6.4. Temperature measurements: Thermo couples, thermisters, optical pyrometers. Calibration of temperature measuring devices.

6.5. Determination of count, event per unit time (EPUT) and time interval: Electronic counters, EPUT meters, time interval meters, Stroboscope.

Text Books:

1. R.K.Jain, " Engineering Metrology ", Khanna Publishers,
2. Elanchezian "Engineering Metrology" Umesh Publications
3. R.S.Sirohi and H.C.Radhakrishna, " Mechanical Measurements ",New Age International

References:

1. Gaylor, Shotbolt and Sharp, " Metrology for Engineers ", O.R.Cassel, London,
2. T.G.Beckwith Mahangoni, Lienhard, " Mechanical Measurements ",Pearson Education.
3. Thomas, " Engineering Metrology ", Butthinson & Co.,
4. E.O. Doeelin, D.N.Malik, “ Measurement systems” Tata Mc Graw Hill.
5. Connie Dotson, Roger Harlow, R.L. Thompson,: “ Fundamentals of Dimensional Metrology” Thomson Delmar Learning.

M.E. 6.5 Mechatronics

Course Objective:

- To learn the basics of control systems and system modeling in engineering and application of concepts in process and manufacturing industries.
- To learn various types of sensors and signal conditioning elements used in mechatronics.
- To provide a glimpse of data presentation and data acquisition systems.
- To learn the basics of hydraulics and pneumatics and their application in industries.
- To understand the various electrical devices used in mechatronics.
- To introduce the students to microcontroller architecture and programming.
- To know about the basic elements of a CNC machine.
- To make the students aware of the recent developments and trends in mechatronics

Instructional Objective: Help the students to apply the knowledge of electrical and electronics engineering in the field of mechanical engineering for automation, process control and computer integrated manufacturing.

Lecturer per week	: 3
Tutorials per week	: 1
Max. Marks for theory paper	: 100
Max. Marks for sessional	: 25
Duration of the paper	: 3 hour
Total no of modules	: 4
No. of question from each module	: 2
Total no of question to be answered	: 5 (at least one question from each module)

MODULE-1 (12 hours)

1. INTRODUCTION TO MECHATRONICS: Definition, Open & closed loop control systems, Basic elements of closed loop systems , Case studies of microprocessor based controllers, Introduction to PLC.

2.CONCEPTS OF CONTROL ENGINEERING: Transfer function, Laplace transform, First order & second order systems, Systems with negative feedback, Basics of

Proportional, derivative, Integral ,PI , PID controllers, Digital controllers, Introduction to SIMULINK.

3.SENSORS AND TRANSDUCERS: Performance terminology of sensors , Photoelectric sensors, Inductive & capacitive proximity sensors, Optical encoders-types, Tachogenerator, Microwave & laser sensors, Limit switches, Flow sensors, Selection of sensors, Manufacturing applications of sensors.

MODULE-2 (12 hours)

4. SIGNAL CONDITIONING: Operational amplifier, Integrating & Differential amplifiers, Comparators, Protection, Filtering, Analog to Digital Conversion, Digital to analog converter, Multiplexers, Digital signal processing.

5. DATA ACQUISITION & PRESENTATION: Data acquisition system, Data loggers, LED & LCD displays, Alarm indicators, Add on cards, Elements of a data acquisition & control system, Virtual instrumentation, Data acquisition with lab view.

6. ELECTRICAL ACTUATION SYSTEMS: Relays, Solenoids, Stepper Motors- Types, specifications & control, servomotors**.**

MODULE-3 (14 hours)

7. PNEUMATIC AND HYDRAULIC ACTUATION SYSTEMS: Introduction, Advantages of Pneumatic/Hydraulic systems, the concept of Power Transmission, Pneumatic and Hydraulic systems, Control Valves, Pressure control Valves, Electro pneumatics, Rotary Actuators.

8. INTERFACING OF I/O SYSTEMS: Introduction, Basic I/O interfaces, - Isolated & memory mapped, Direct memory access, Communication with external devices- Polling, Interrupt, Parallel & serial Interfacing, RS232C standard

9. SYSTEM MODELS: Mathematical Models, Electrical system Building Blocks, Electrical and Mechanical Analogies , Fluid system Building Blocks, Thermal system Building Blocks.

MODULE-4 (14 hours)

10. INTRODUCTION TO MICROCONTROLLERS: The 8051 microcontroller, Architecture, Assembly language programming, Assembling and running an 8051 program, Program counter & ROM space , Data types and directives, Flag & PSW register , Register banks & stacks, I/O ports & their functions, Pin diagram**.**

11. MECHATRONIC ELEMENTS: Introduction, Machine Structure, Slip stick phenomenon, Antifriction, Hydrostatic & aerostatic guide ways, Recirculation, Ball screw, Antifriction bearings.

12. RECENT TRENDS IN MECHATRONICS: Embedded systems, Machine vision, Wireless LAN, Bluetooth, RF-ID & bar code identification, USB, Smart sensors. Networking of sensors, Distributed digital control systems, Ethernet, Microelectromechanical Systems

Text books:

1. Bolton.W. Mechatronics, Addison Wesley Longmans, Delhi.
2. C.R. Venkatramana, Mechatronics 2nd edition, Sapna Book House, Bangalore
3. M. Chidambaram, Computer control of processes, Narosa Publishing House

References:

1. TM.A. Mazidi, J.G. Mazidi, R. Mckinlay "The 8051 Microcontroller & Embedded Systems" Prentice-Hall of India, 2006
2. Sabrie Soloman, "Sensors and Control Systems in Manufacturing", McGraw-Hill Book Co., 1987
3. Histand, etal, Introduction to Mechatronics, McGrawHill, Inc. USA
4. Nagrath I.J., & Gopal M, "Control system Engineering." Wiley Eastern Reprint
5. Rajkamal "Embedded Systems" TMH Publication
6. Devdas shetty:etal, Mechatronics system Design, Thomson learning
7. Dan Necsulescu"Mechatronics" Pearson Education Asia.
8. HSU "MEMS and Microsystems design and manufacture" Tata McGraw Hill.

M.E. 6.6 Operations & Project Management

Lectures per week	:	3 hours
Tutorials per week	:	1 hour
Max marks of theory paper	:	100
Max marks for sessionals	:	25
Total number of modules	:	4
Total number of questions to be answered	:	5

Course Overview

Operations Management is the systematic direction and control of the processes that transform inputs into finished goods or services. Operations is one of the primary functions of a firm. While marketing induces the demand for products and finance provides the capital, operations *produce and deliver* the product (goods and services).Operational issues include designing, acquiring, operating, and maintaining the facilities and processes; purchasing raw materials; controlling and maintaining inventories; and providing the proper labor needed to produce a good or service so that customers' expectations are met. This course in operations management is intended to be a survey of operating practices and models in both manufacturing and service oriented firms.

Course Objectives

- Build an understanding of how the Operations Manager fits into the organization.
- Provide a knowledge base for conversing with operations personnel.
- Build both quantitative and qualitative analysis skills, especially those needed for managing operating systems.
- Provide modeling concepts which can be used to help managers evaluate various management problems.
- Show the similarities of operating problems in the Manufacturing and Service Sectors.

MODULE I

1 . Introductions: Concepts in operations planning and concepts for various operational systems in manufacturing and service sectors.

2. Forecasting Techniques: Forecasting as a planning tool, forecasting time horizon, short and long range forecasting, sources of data, types of forecasting, qualitative forecasting techniques, quantitative forecasting models - Linear regression, Moving average, Weighted moving average, Exponential smoothing, Exponential smoothing with trends, Techniques for seasonality cycles, techniques for cycles, Measurement of errors, accuracy and control of forecast.

3. Concepts and quantitative methods in plant location : Need and nature of location decisions, factors affecting location decisions and their relative importance for different types of facilities, Evaluating Location alternatives – break even analysis, transportation model, factor rating, center of gravity method.

MODULE II

4. Concepts and quantitative methods for plant layout: Layout and its objectives, principles, types of plant layouts – product layout, process layout, fixed position layout, cellular manufacturing layouts, hybrid layouts, Factors influencing layout changes.

5. Assembly Line Balancing : Concept of work stations, cycle time, idle time. Assigning task to work station using single rule or combination of rules - task times, following tasks, positional weight.

6. Aggregate Planning and Master Production Scheduling : Purpose and scope, basic strategies of aggregate planning, techniques for aggregate planning. Master scheduling.

MODULE III

7. Inventory Control, MRP and CRP: Dependent and independent demand. Inventory control, EOQ models for purchasing and manufacturing situation with and without shortages, MRP and CRP

8. Sequencing and Scheduling : Scheduling operations, Scheduling in low volume systems-Gantt chart, assignment model. Sequencing, priority rules, single processor system, two processor and multi-processor systems, Johnson's rule , Jackson's rule.

MODULE IV

9. Product mix situations using LP techniques: Formulation of linear programming problem, Simplex method (Analytical & Graphical), Big M method.

10. Project Planning and Control: Network analysis - PERT and CPM, Total slack, free slack, Probability of achieving completion date, Cost analysis, crashing of projects.

Text Books

1. Monks J. G., Operations Management: Theory and Practical McGraw Hill, 1985.
2. William J. Stevenson: Production/operations Management

References:

1. Martin K Starr, Operations Management, Prentice Hall.
2. Vollman Thompson etal, Manufacturing Planning and Control Systems.
3. Fogarty Donald W and Hoffman Thomas R, Production and Inventory
4. Management, South Western Publishing Comp
5. Montgomery D C and Johnson L A Operations Research in Production Planning and Control.

ME 6.7 Practicals In GAS DYNAMICS AND TURBOMACHINERIES

Course Objectives:

- To understand turbmachinery behaviour under constant speed.
- To gain insight into constant head behaviour of turbo-machineries.
- To gain insights into operational ranges, behavioural trends and shortcomings across different compressible and incompressible equipments.

Instructional Objectives:

- To teach students the operation of various energy conversion devices that help students understand the devices used in diverse sectors of energy , process, and manufacturing.
- To help students gain knowledge about compressible and incompressible machineries.

No. of Hours per week :2 hours

Max marks for practicals :25

List of Experiments

1. To study the constant speed (operating) characteristics of Pelton wheel turbine.
2. To study the constant head (main) characteristics of Pelton wheel turbine.
3. To study the constant speed (operating) characteristics of the Kaplan Turbine.
4. To study the constant head (main) characteristics of the Kaplan Turbine.
5. To study the constant speed (operating) characteristics of Centrifugal pump.
6. To study the constant head (main) characteristics of centrifugal pump.
7. To study the operating characteristics of Gear pump at constant speed.
8. To conduct performance test on centrifugal blower.
9. To study the constant speed (operating) characteristics of Reciprocating pump.

M.E.6.8 Practicals in Engineering Measurements and Metrology

Course Objectives: To carry out the experiments to understand and appreciate the application of standards in quality control.

Instructional Objectives: Help the students to lean the principle, construction, operation and application of different measuring instruments used to measure different mechanical quantities.

The Term work should be in the form of Journal consisting of following three sections

No. of Hours per week :2 hours
Max marks for practicals :25

A) Experiments: (Any eight of the following)

1. Measurement of straightness, flatness, roundness.
2. Measurement of the Surface roughness.
3. Measurement of angle by sine bar / Sine center.
4. Measurement of various elements of screw thread using Tools Makers Microscope.
5. Measurement of Screw thread parameters using Floating Carriage Micrometer.
6. Measurement of Gear tooth thickness using Gear tooth Vernier caliper and Span Micrometer.
7. Study and Experiment on Profile Projector.
8. Straightness measurement using Autocollimator
9. Measurement of dimensions using Vernier Height Gauge.
10. Alignment Test on Lathe/ Drilling/Milling Machine
11. Experiment to measure Process Capability using Statistical Process Control.
12. Determining the accuracy of electrical and optical comparator.

B) Experiments (any 3 of the following)

1. Calibration of LVDT
2. Calibration of Piezo electric transducers.
3. Calibration of Strain Gauge
4. Calibration of Load cell
5. Calibration of pressure cell.

6. Calibration of Pyrometers.

C) Assignments

1. Limits, fits and tolerances.
2. Coordinate measuring machine
3. Geometric tolerance.
4. Application of Machine vision in metrology.

M.E. 6.9 Practicals in Mechatronics

Course Objectives:

- To conduct experiments on various transducers to understand their characteristics and their behavior.
- To learn to design pneumatic circuits.
- To gain insight into data acquisition with graphical programming by Lab View software.
- To write programs in assembly language for microcontroller
- To design signal conditioning circuits

Instructional Objectives: To teach students the concepts of various mechatronics devices and conduct experiments on the same.

No. of Hours per week :2 hours

Max marks for practicals :25

List of Experiments

1. Experiment on LVDT trainer

2. Experiment on Strain gauge trainer

3. Experiment on Temperature transducer (Thermocouple)

4. Data acquisition from pressure sensor using LabView

6. Data acquisition from Flow sensor using LabView

7. Data acquisition from temperature sensor using LabView

8. Design of signal conditioning circuits

9. Simple programs in assembly language using 8051 microcontroller

10. Simulation of industrial process control using LabView

11. Exercises on control system using LabView & SIMULINK

12. Experiment on process control trainer