EVALUATION SCHEME & SYLLABUS
FOR
B. Tech. 3rd Year
Production Engineering
ON
CHOICE BASED CREDIT SYSTEM (CBCS)
[Effective from session 2018-19]
**V SEMESTER**

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**Department Elective Course –I**

1. RPI051: Facility Planning and Layout Design.
2. RPI052: Tool Engineering
3. RME055: Advance Manufacturing Science
4. RME052: Mechatronics & Microprocessor
UNIT I

Introduction
Design requirements of machine elements, Principles of mechanical design, Modes of failures and Factor of Safety. Systematic design process, Aesthetic and Ergonomic considerations in design, Use of standards in design, Manufacturing consideration in design, Selection of preferred sizes, Indian Standards designation, Designation of carbon & alloy steels, Selection of materials for static and fatigue loads.

UNIT II

Design for Static and Fluctuating Loads
Cyclic stresses, Fatigue and endurance limit, Notch sensitivity, Stress concentration. Design for finite and infinite life, Soderberg, Goodman & Gerber criteria.

Shafts, Keys and Couplings
Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads.
Types of keys, splines, Selection of keys, Strength of keys, Design of rigid and flexible couplings.

UNIT III

Design of Mechanical Drives
Introduction to power transmission and drives. Classification of gears, Terminology, Gear tooth proportions, Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Failure of gear tooth, Design considerations, AGMA and Indian standards, Beam strength and wear strength of gear tooth, Design of spur and helical gears.

UNIT IV

Mechanical Springs
Classification of springs, Material for helical springs, End connections for compression and tension helical springs, Design of helical springs subjected to static and fatigue loading.

Power Screws
Forms of threads, multiple threads, Efficiency of square threads, Trapezoidal threads, Stresses in screws, Design of screw jack.

UNIT V

Basic of Finite Element Method, Variational calculus, Integral formulation, variational methods: Methods of weighted residuals, Approximate solution using variational method, Modified Galerkin method, Boundary conditions.

Note: Design data book is allowed in the examination
Text Books:
2. Design of Machine Elements, Sharma and Purohit, PHI.
9. P Seshu, Finite Element Analysis, PHI publications, Delhi


References:
1. Design of Machine Elements-M.F. Spott, Pearson Eductaion
4. Design of Machine Elements, Gope PHI.
5. Finite Element Method with Applications in Engineering Y M Desai, Pearson Publication
6. Introduction to Finite Element Analysis by Tirupathi R.Chandrupatla & Ashok D Belegundu, Pearson Publication
UNIT I

**Introduction**: Classification of machine tools based on application and production rate: General purpose and Special purpose machines, Classification based on-types of machine tools and the processes.


UNIT II

**Lathe**: Various types of lathe: Centre lathe, facing lathe, gap-bed lathe, capstan and turret lathe, NC, CNC and DNC lathe, major difference between CNC lathe and conventional lathe. Major sub-assemblies of a lathe: Bed, headstock, tail stock, carriage consisting of saddle, cross-slide, compound slide, tool post and apron. Work holding devices: self centering three jaw chuck, independent four jaw chuck, collets, face plates, dog carriers, Centers and mandrels, Rest(Steady and Moving).

UNIT III

**Lathe Contd..**: Driving mechanisms, apron mechanism, thread cutting mechanism and calculations, features of half-nut engagement – disengagement, indexing dial mechanism. Operations on lathe: taper turning, related calculations, thread cutting, facing, under-cutting, drilling, boring, parting-off, knurling, chamfering.

**Reciprocating Type Machine Tools**: Shaper, Planer and Slotter: Constructional features, basic machines and kinematics and related calculations.

UNIT IV

**Drilling Machines**: Constructional features of bench drilling machine, radial drilling machine, multi-spindle drilling machine, feed mechanism, work holding devices, Tool – holding devices. Different drilling operations: Drilling, reaming, counter boring and countersinking etc. estimation of drilling time.

**Milling Machines**: Types of general purpose milling machines: horizontal, vertical, universal and their principal parts. Types of milling cutters and their applications, different milling operations, work-holding devices: vice, clamps, chucks, dividing head and its use, simple, compound and differential indexing. Indexing calculations and machining time calculations. Introduction to machining centers.

UNIT V

**Grinding Machines**: Different types of grinding machines: cylindrical, surface and centre-less grinding machines, basic constructional features and mechanisms, specifications, different grinding operations, honing, lapping and super-finishing processes.

**Gear Manufacturing Machines**: Gear forming, gear generation, gear shaping and gear hobbing.
Reference Books:

ADVANCED WELDING TECHNOLOGY

Unit-I

Introduction: Importance and application of welding, classification of welding process. Selection of welding process.


Unit-II

Advanced welding Techniques - Principle and working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding etc.

Unit-III

Advanced welding Techniques (continued): Principle and working and application of advanced welding techniques such as explosive welding/ cladding, Underwater welding, Spray-welding / Metallising, Hard facing.

Unit-IV


Unit-V


Books

1. Welding Hand Book
1. Design & Modeling of Cotter joint.
2. Design & Modeling of Knuckle joint
3. Design & Modeling of riveted joint applied to boiler joints.
4. Study of a FEA package and modeling stress analysis of
   a. Bars of constant cross section area, tapered cross section area and stepped bar
   b. Trusses,
   c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc

5. Mini Project: Will take up problems from real life applications and optimize using
   modeling and analysis software
   Each student will be given a real life problem for the complete design of a subsystem/system
   using either manual calculation with the help of design handbook or through computer
   programme or through software tools. This assignment should be done in groups, which will
   be submitted at the end of the semester.

Text Books:
2. Design of Machine Elements, Sharma and Purohit, PHI.
8. P Seshu, Finite Element Analysis, PHI publications, Delhi

by K. Mahadevan, and K. Balaveera Reddy

References:
1. Design of Machine Elements-M.F. Spott, Pearson Eductaion
4. Design of Machine Elements, Gope PHI.
5. Finite Element Method with Applications in Engineering Y M Desai, Pearson Publication
6. Introduction to Finite Element Analysis by Tirupathi R.Chandrupatla & Ashok D Belegundu,
   Pearson Publication
Minimum eight experiments out of the following along-with study of the machines / processes

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine.
2. Bolt (thread) making on Lathe machine
3. Tool grinding (to provide tool angles) on tool-grinder machine.
5. Machining a block on shaper machine.
7. Drilling holes on drilling machine and study of twist-drill.
8. Study of different types of tools and its angles & materials.
9. Experiment on tool wear and tool life.
10. Experiment on jigs/Fixtures and its uses
11. Gas welding experiment
12. Arc welding experiment
14. Soldering & Brazing experiment
1. Making of welded joints using conventional welding processes - arc welding.
3. Making of at least one joint using TIG welding techniques.
4. Making of at least one joint using MIG welding techniques.
5. Testing of welded joints as per BIS.
7. Inspection of welded joints by dye penetration ultrasonic method.
8. Study of different techniques used for inspection of welds.
Department Elective Course –1

1. Facility Planning and Layout Design.
2. Tool Engineering
3. Advance Manufacturing Science
4. Lean Manufacturing.
5. Mechatronics & Microprocessor

FACILITY PLANNING AND LAYOUT DESIGN

Unit I

Plant Location and layout: Factors influencing plant location, location economics - problems. Objectives of plant layout, Principles of plant layout, types of plant layout, their merits and demerits. Line Balancing

Unit II

Material Handling: Objectives and principles of Material handling, Unit load concept, classification and types of material handling equipment, Modern material handling concepts and equipment, RFID. Muther’s Systematic Layout Planning procedure – problems.

Unit III

Space Determination and Area Allocation: Factors for consideration in space planning, area allocation factors to be considered, Plot plan, Sequence demand Straight line and non directiona methods – Analytical treatment. Determination of manpower and equipment requirement, use of travel chart for layout planning, analytical treatment.

Unit IV

Layout Evaluation: Methods of constructing the layout, efficiency indices. Layout models: Single facility and multi facility location models, warehouse layout models, Warehouse design as per International standards. Conveyor and Storage models (discussion only)

Unit V

Layout for software and service organizations: An over view

Text Books:

References:
TOOL ENGINEERING

Unit I

General Considerations:

Tool classification, Tool materials, properties & applications, Tooling economics General design considerations, Safety aspects.

Unit II

Design Of Metal Cutting Tools:


Multipoint cutting tool: Design of drills, reamers, milling cutters, broach & gear cutting tools.

Unit III

Design Of Metal Working Tools:

Design of press working tools, shearing, piercing, blanking, dies, compound die design, progressive dies, bending, forming drawing dies. Tooling for Forging-Design principles for forging dies, Drop forging, upset forging. Design principles and practice for rolling, Roll pass Design.

Unit IV


Unit V

Design Of Gauges And Inspection Features: Design of gauges for tolerance for dimensions and form inspection.

Dies And Mould Design For Plastics & Rubber Parts: Compression moulding, transfer moulding, blow moulding.

Suggested Books:

1. Fundamentals of Tool Design Wilson ASTME
2. Tooling for production parron
3. Tool Design Donaldson T.M.H.
5. Die Design Hand Book by ASTME/ McGraw Hill
6. Metal cutting & Cutting Tool Design Archinov MIR Publishers Moscow Introduction to Jig and Tool Design M. H. A. Kempster FLBS
ADVANCED MANUFACTURING SCIENCE

Unit I

Introduction: Introduction to Advanced Manufacturing processes and its classification.

Mechanical Type Material Removal Processes: Ultrasonic machining; Elements of the process; Tool design and economic considerations; Applications and limitations, Abrasive jet and Abrasive water jet machining principles; Mechanics of metal removal; Design of nozzles; applications, Abrasive finishing process, Magnetic abrasive finishing process.

UNIT II

Thermal Type Material Machining Processes: Classification, General principles and applications of Electro discharge, Plasma arc, Ion beam, Laser beam, Electron beam machining, Mechanics of metal removal in EDM, selection of EDM pulse generator dielectric, machining accuracy, surface finish and surface damage in EDM, Generation and control of electron beam for machining applications, advantages and limitations.

UNIT III

Chemical and Electro-chemical Type Material Removal Processes: Principle, working advantages, disadvantages and applications of Electrochemical, Chemical machining, Economy aspects of ECM, Electro-chemical deburring and honing.

UNIT IV

Hybrid Machining Processes: Introduction and working Principal of ECDM, ECAM, Abrasive EDM, Micro EDM etc.

UNIT V

Unconventional Forming processes: Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro Discharge forming, water hammer forming, explosive compaction etc.

Electronic-device Manufacturing: Brief description of Diffusion and Photo- Lithography process for electronic-device manufacturing

Books:
1. Advance Machining Processes V.K. Jain New Age
2. Modern Machining Processes P.C. Pandey New Age
3. Manufacturing Processes Degarmo -
LEAN MANUFACTURING

Unit I


Unit II


Unit III
Maintaining and Improving Equipment: Equipment Maintenance, Equipment Effectiveness, Preventive Maintenance Program, Total Productive Maintenance, Implementing TPM.

Pull Production Systems: Production Control Systems, Process Improvement, How to Achieve Pull Production, Other Mechanisms for Signal and Control, To Pull or Not to Pull.

Unit IV

Unit V

Text Books:

References :
UNIT - I

Introduction to Mechatronic Systems: Measurement and control systems their elements and functions, Microprocessor based controllers.


UNIT - II

Electrical Actuation Systems: Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits.


UNIT-III

Introduction to Microprocessors: Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors.

Review of concepts - Boolean algebra, Logic Gates and Gate Networks, Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation.

UNIT -IV

Logic Function: Data word representation. Basic elements of control systems 8085A processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers.

UNIT V

Organization & Programming of Microprocessors: Introduction to organization of INTEL 8085-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming.

Central Processing Unit of Microprocessors: Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization.

REFERENCE BOOKS:
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**Department Elective Course –2**

1. RPI061: Instrumentation And Control.
2. RME065: Product Data Management.
4. RPI062: Human Factors in Engineering.
MACHINE TOOL TECHNOLOGY

Unit I – Drives

Design considerations for drives based on continuous and intermittent requirement of power, Types and selection of motor for the drive, Regulation and range of speed based on preferred number series, geometric progression. Design of speed gear box for spindle drive and feed gear box. Stepless drives, Design considerations of Step less drives, electromechanical system of regulation, friction, and ball variators, PIV drive, Epicyclic drive, principle of self locking.

Unit II - Design of Machine Tool Structures:

Analysis of forces on machine tool structure, static and dynamic stiffness. Design of beds, columns, housings, bases and tables.

Unit III - Design of Guide-ways and Power Screws

Functions and types of guide ways, design criteria and calculation for slide ways, design of hydrodynamic, hydrostatic and aerostatic slide ways, Stick-Slip motion in slide ways. Design of power screws: Distribution of load and rigidity analysis.

Unit IV - Design of Spindles and Spindle Supports

Design of spindle and spindle support using deflection and rigidity analysis, analysis of antifriction bearings, preloading of antifriction bearing.

Unit V - Dynamics of machine tools


Unit VI - Advances in Machine Tool Design

Design considerations for SPM, NC/CNC, and micro machining, Retrofitting, Recent trends in machine tools, Design Layout of machine tool using matrices.

Text Books:


Reference Books:

Unit I

**Introduction to Simulation:** Simulation, advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study.


Unit II

**Simulation Examples:** Simulation of Queuing systems, Simulation of Inventory System, Monte Carlo simulation, General Principles, Concepts in discrete - events simulation, event scheduling / Time advance algorithm.

Unit III

**Introduction to Probability distributions:** Weibull, Triangular, Erlang and Gamma distributions and their applications (No analytical treatment)

**Random Variate Generation:**
Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and lognormal Distributions
Convolution Method – Erlang distribution Acceptance and Rejection technique – Poisson and Gamma distributions

Unit IV

**Input Modeling:** List of steps involved in input modeling – no analytical treatment Selecting input models without data, Multivariate and time series input models – Covariance and correlation, multivariate input models, time series input models

**Verification and Validation of Simulation Model:** Model Building, Verification and validation, Verification of simulation models, Calibration and Validation of Models, Naylor and Finger’s validation process.

Unit V

**Output analysis for a single model:** types of simulations, stochastic nature of output data, Output analysis of terminating simulations, Output analysis of steady state simulations

**Optimization via simulation:** What does “optimization via simulation” mean? Why is optimization so difficult? Basic GA and TS.

**Text books:**

**Reference:**
OPERATIONS PLANNING AND CONTROL

Unit I


Unit II


System Design and Capacity: Introduction, Manufacturing and service systems, Design and systems capacity, Capacity planning.

Unit III

Forecasting Demand: Forecasting objectives and uses, Forecasting variables, Opinion and Judgmental methods, Delphi technique, Time series methods, Moving Average methods, Exponential smoothing, Trend adjusted Exponential Smoothing, Regression and correlation methods, Application and control of forecasts-Mean Absolute Deviation, BIAS, and Tracking Signal.

Unit IV

Aggregate Planning and Master Scheduling: Introduction- planning and scheduling, Objectives of aggregate plan, Three Pure Strategies of Aggregate planning, aggregate planning methods, Master scheduling objectives, Master scheduling methods.
MACHINE TOOL SYSTEM LABORATORY

1. Study of speed structure (Ray Diagram) of lathes,
2. Determination of apron constant, measurement of cutting forces and tool wear experiments are also to be done to
3. Study principles of metal cutting;
4. Alignment tests of drilling machines,
5. Experiment on study of Quick return motion mechanism on shaper
6. Experiment involving machining of complex product configurations,
7. Machining of spur and helical gears, copying and contouring,
8. Finishing processes and grinding of tools and cutters.
SIMULATION MODELING AND ANALYSIS LAB

1. Introduction to Simulation Packages and selection.
2. Understanding the Simulation Package
3. Identifying probability distributions for given data
4. Building simulation models for manufacturing operations (Electronic assembly – With Basic templates)
5. Building simulation models for manufacturing operations (Electronic assembly – With Common templates)
6. Building simulation models for manufacturing operations with transport System
7. Building simulation models for manufacturing operations with layout
8. Building simulation models for manufacturing operations with layout and transport System
9. Building simulation Models for Banking service (Bank teller problem)
10. Building simulation Models for Mortgage application problem
11. Building simulation Models for food processing problem
12. Building simulation Models for Post office animation
13. Statistical Analysis of Simulation models (input analysis)
14. Statistical Analysis of Simulation models (output analysis)
15. Simulation model for foundry exercise.

Text books:

Reference:
OPERATIONS PLANNING AND CONTROL LAB

Laboratory Exercises
2. Generating Bill of Materials for Various Engineering Designs
3. Creating Item Master for various Engineering Designs
4. Conduction of vendor Evaluation exercise
5. Creating Make Master for Items
6. Creating Purchase order for Items
7. Creating Work order for Items
8. Perform inventory transaction
9. Creating quotation process for Items
10. Creating Dispatch Instruction for Items
11. Creating Payment reconciliation.
12. MRP - II Generating of Various reports for confirmed orders
13. Optimization problems using OR packages (two exercises only).
14. Scheduling of activities

Suggested Software Packages
1. Statistical Packages : SYSTAT / MINITAB and such others
2. ERP Packages : SIXTH SENSE / UNISOFT / OPTIMIZER 10.6 and such others.
3. Preactor – Scheduling Software OR Packages : Lindo / Lingo / STORM / such as others

REFRIGERATION & AIR CONDITIONING Lab

Minimum eight experiments out of the following:

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. Study of different types of expansion devices used in refrigeration system.
3. Study of different types of evaporators used in refrigeration systems.
4. To study basic components of air-conditioning system.
5. Experiment on air-conditioning test rig & calculation of various performance parameters.
6. Experiment on air washers
7. Study of window air conditioner.
8. Study & determination of volumetric efficiency of compressor.
10. Visit of cold-storage and its detailed study.
11. Experiment on Ice-plant.
12. Experiment on two stage Reciprocating compressor for determination of volumetric efficiency, PV diagram and effect of intercooling.
14. Experiment on Desert coolers.
Department Elective Course –2

1. Instrumentation And Control.
2. Product Data Management.
4. Human Factors in Engineering.
5. Quality Engineering in Manufacturing

INSTRUMENTATION AND CONTROL

UNIT-I
Basic Concepts of Instrumentation: Accuracy and precision of measurement, types of error, statistical analysis of error, electrical standards, IEEE standards. Types of noises i.e. White noise, grey noise and colored noise.

UNIT II
Use of analysis tools of MATLAB, SCILAB, DFT, FFT, IFFT, Linear and Circular co-relation tools etc. Windowing: Black Man Herris, Flat Top, Hamming, hanning, Co-efficient windows. Use of windows to reduce leakage

UNIT III
Filters: Design of the analog filters like Butterworth, Bessel, Chebyshev, designing FIR/IIR filters. Signal Processing: Auto/cross – correlation, discrete Fourier transform, convolution, power spectrum, inverse transforms, and signal amplification

UNIT-IV
Basic Sensors and Transducers: LVDT: Principle and applications, Signal conditioning of the signal measured by LVDT. Strain gauges: Principle and applications, Signal conditioning of the signal measured by strain gauges. Optical fiber based sensors: Principles of optical fiber technology, types of light emitters and absorbers etc.

UNIT-V
Signal Measurement: Digital and analog data acquisition, Types and architecture of data actuation cards. Interfacing: Methods of interfacing transducers to measurement system. Multiplexing: Meaning of multiplexing and types of multiplexing methods.

Basic Concepts of Control: Discrete and Continuous time control. Laplace and z- transform. Time domain control theories like Pole placement; Frequency domain control theories like Lead and Lag compensators.

Spoken Tutorial (MOOCs):
Spoken Tutorial MOOC, 'Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)
TextBooks


PRODUCT DATA MANAGEMENT

UNIT-I

Introduction: Introduction to PDM-present market constraints need for collaboration- Internet and developments in server-client computing, Collaborative product commerce.

UNIT-II

Components of PDM: Components of a typical PDM set-up hardware and software- document management creation and viewing of documents -creating parts-version control of parts and documents –case studies.

UNIT-III


UNIT-IV

Change Management: Change issue -change request-change investigation- change proposal-change activity-case studies.

UNIT-V

Generic Products and Variants: Products configuration comparison between sales configuration mild products generic-generic product modeling in configuration mode1er-use of order generator for variant creation –registering ofvarian1s in product register-case studies.

REFERENCE BOOKS:
UNIT-I

Introduction Digital image representation; fundamental steps in image processing; elements of digital image processing systems: image acquisition, storage, processing and display. 2. Digital Image Fundamentals : Structure of the human eye; image formation; brightness adaptation and discrimination; a simple image model; uniform and non-uniform sampling and quantization; some basic relationships between pixels; neighbors of a pixel; connectivity; Labeling. Distance measures; imaging geometry.

UNIT-II

Image Enhancement in the spatial domain 4L Basic gray level transformations-histogram processing-Enhancement using arithmetic/logic operations-Basics of spatial filtering-comparison between smoothing and sharpening spatial filters.

UNIT-III

Image Enhancement in the frequency domain 4L 1D Fourier transform-2D Fourier transform and its Inverse-Smoothing & sharpening frequency domain filters (Ideal, Butterworth, Gaussian)-homomorphic filtering.

Image compression 4L Fundamentals-Image compression, Error-free compression: Huffman coding, block coding, constant area coding, variable length coding; bit-plane coding; lossless predictive coding.

UNIT-IV

Machine Vision 12L Introduction, definition, human visual system. Active vision system, increasing of machine vision. Machine vision components, hardware’s and algorithms, image function and characteristics, image formation & image sensing frequency space analysis, Fourier transform, convolution algorithms, image gaussian, image enhancement, image analysis and segmentation data reduction, feature extraction, edge detection, image recognition and decisions, m/c learning, image processing, machine vision edges detection, application in the area such as inspection part identification, industrial robot control, mobile robot application. Industrial MVs in production and services, structure of industrial m/c vision, generic standards, rules of thumb, image formation, illumination, optics, interfacing machine vision system. Vision system calibration.

UNIT-V.

2D & 3D vision 6L 16 Competing technologies, principle, CCD, Videcon and other cameras, data capture. Triangulation geometry, resolution, passive and active 3-D stereo imaging, data processing

References:

2. Introduction to AI and Expert Systems by D.W.Patterson, Prentice Hall.
3. Rajiv Chopra, Machine Learning, Khanna Publishing House


**HUMAN FACTORS IN ENGINEERING**

Unit I

**Introduction**
Introduction to Human factors, History of Human factors, Human machine systems, Displaying information, coding of information, information processing, memory, decision making, age and information processing, mental workload.

Unit II

**Visual Displays:** The process of seeing, Visual acuity types, quantitative visual displays, Dynamic quantitative displays, Qualitative visual displays, Representational displays

Unit III

**Auditory, Tactual & Olfactory Displays:** The nature and measurement of sound, The anatomy of ear, Auditory displays, principles of auditory displays, Tactual display types, The Olfactory sense and displays.

Unit IV

**Human activities:** Muscle physiology, Measure of physiological strain, physical work load, factors affecting, energy consumption, Strength and endurance, Biomechanics of human motion, Function of controls, factors in control design, C/R ratio, Optimum C/R ratio, Principles of hand tool and device design.

Unit V

**Work space and arrangement:** Anthropometry, use of anthropometric data, work spaces, design of work surfaces, science of seating, example of individual work place, human error, accidents and warnings

**Applications:** use of ergonomics in service sector and IT sector.

**Introduction to BIS on Human factors.**

**Text Books:**

**References:**
QUALITY ENGINEERING IN MANUFACTURING

UNIT I
Quality Value and Engineering: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type, S-type and L-type)

UNIT II
Tolerance Design and Tolerancing: Functional limits, tolerance design for N-type, L-type and S-type characteristics, tolerance allocation for multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT III
Analysis of Variance (ANOVA): NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT IV
Orthogonal Arrays: Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

UNIT V
ISO-9000 Quality System, BDRE, 6-sigma, Bench making, Quality circles Brain Storming — Fishbone diagram — problem analysis.

Text Book:

Reference Books:
