



---

## Course Structure and Syllabus

For  
**Pre Ph.D.**

---

# DEPARTMENT OF MECHANICAL ENGINEERING

(Engineering & Technology)

---

[2021-22]



**CHAITANYA (DEEMED TO BE UNIVERSITY)**

**Kishanpura, Hanamkonda,  
Warangal Urban, Telangana-506 001**

[www.chaitanya.edu.in](http://www.chaitanya.edu.in)

**CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL**  
Course Structure and Syllabi for Pre Ph.D.



---

## MECHANICAL ENGINEERING (2020-2021)

### PAPER – I: RESEARCH METHODOLOGY

(Common for all Specializations)

(Effective from the admitted batch 2021–22)

Number of Contact hours: 40

Credits: 4 Marks: 100

#### PAPER- I

#### RESEARCH METHODOLOGY

**Objective:** This paper highlights the various postulates of research problems, research design, writing a thesis and modern statistical methods. This helps to carry out research problem individually in a perfect scientific method.

#### Unit-I:

Meaning of Research - Function of Research

Meaning of Research - Function of Research – Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature review.

Identification of Research Problem Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem – Source of problems – Personal consideration.

#### Unit- II:

Research Design

Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design. Different research designs – Basic principles of experimental designs – Computer and internet in designs.

Data Collection and analysis

Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation.

#### Unit-III:

Reporting and thesis writing

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables

Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice –

Making presentation – Use of visual aids - Importance of effective communication –



---

**Unit -IV:****Statistical Techniques and Tools**

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete series and continuous series) – Correlation - Regression – Multiple Regression. Sampling distribution – Standard error – Concept of point and interval estimation – Level of significance – Degree of freedom – Analysis of variance – One way and two way classified data – ‘F’-test.

**Unit -V:****Application of results and ethics**

Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

**Text Books and References:**

1. A Hand Book of Methodology of Research, Raja mall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press, 1976.
2. Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint 2008.
3. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
4. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011.
5. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi, 1999.
6. Statistical Methods , G.W. Snedecor and W.G. Cochran, Iowa state University Press, 1967.



**PAPER – II**

Choose any **one** subject of the following

<b>Sl. .NO</b>	<b>PAPER</b>	<b>PAPER CODE</b>
1	Thermal Engineering	20PH03101
2	Mechanical Engineering Design	20PH03102
3	Industrial Engineering	20PH03103
4	Advanced Production Technology	20PH03104
5	Material Technology	20PH03105
6	Refrigeration Equipment and Cryogenic Engineering	20PH03106
7	Heat and Mass Transfer	20PH03107
8	I.C. Engines and Alternative Fuels	20PH03108
9	CAD Theory and Practice	20PH03109
10	Mechanical Vibrations and Condition Monitoring	20PH03110
11	Design for Manufacture	20PH03111
12	Special Manufacturing Processes	20PH03112
13	Industrial Robotics	20PH03113
14	Simulation Modeling and Analysis of Manufacturing Systems	20PH03114
15	Advanced Optimization Techniques	20PH03115
16	Logistics and Supply Chain Management	20PH03116
17	Advanced Operations Management	20PH03117
18	Mechanics of Composite materials	20PH03118
19	Energy Conservation	20PH03119
20	Computational Methods	20PH03120



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03101) THERMAL ENGINEERING

### Unit 1:

Thermodynamic property relations: Availability (Exergy) – Unavailability (Anergy) – Irreversibility – Partial derivatives – Maxwell's relations – Clausius Clayperon equation – General relations for  $du$ ,  $dh$ ,  $ds$ ,  $C_v$ ,  $C_p$  for ideal gases (pure substances) and real gases.

Gas Mixtures: Composition of a Gas mixture – mass and mole fractions – PVT behavior of gas mixtures (Ideal and Real gases) – Properties of gas mixtures (Ideal and Real gases) Combustion: Theoretical and actual combustion processes – Enthalpy of formation – Enthalpy of Combustion – First Law analysis of Reacting Systems – Second Law analysis of Reacting systems.

### Unit 2:

Gas power cycles: Carnot cycle - Air standard assumptions - Overview of reciprocating engines - Otto cycle - Diesel cycle – Dual cycle – Stirling cycle – Ericsson cycle – Brayton cycle – Brayton cycle with Intercooling, Reheating and Regeneration.

Vapor power cycles: Carnot vapor cycle – Ideal Rankine cycle – Deviation of Actual Vapor power cycle from Ideal cycle – Actual Rankine cycle – Methods to increase efficiency of Rankine cycle (Lowering of condenser pressure, Super heating steam to High temperature, Increasing Boiler pressure) – Ideal Reheat Rankine cycle

### Unit 3:

Gas Turbines - Gas Turbine cycle – Combined cycle analysis – Design for high temperature combined cycles with heat recovery boiler – STAG combined cycle power plant – Combined cycle with multi pressure steam, Influence of component efficiencies on cycle performance – Combined cycle with Nuclear power plant – ICGCC plant.

### Unit 4:

Heat Transfer: Conduction and Single-phase Convection – Introduction – Modes of heat transfer – Combined modes – Steady one-dimensional – Steady heat source system – Forced convection – Boundary layer flow with heat transfer – Equations of momentum and energy – Integral method of solution – Free convection from vertical, horizontal and inclined plates.

Heat Transfer to Fluids with Phase Change – Heating and cooling of fluids in forced convection outside tubes – Heat transfer from condensing vapors – Heat transfer to boiling liquids.



### **Unit 5:**

IC Engines: Classification- Engine components, valve timings and mechanism, Spark ignition, four stroke Engine, carburetor, air fuel mixtures, mixture requirements, simple plain tube carburetor, fuel pump- ignition system, fuel pump and injector, two stroke engine, scavenging of two stroke engine.

Refrigeration: Simple vapour compression cycle, units of refrigeration, reversed carnot cycle for vapour, actual refrigeration cycle, the effect of sub cooling, superheating, common refrigerants.

### **References:**

1. Engineering Thermodynamics by P.K.Nag /TMH
2. Thermo dynamics by Sontag & Van Wylen/Mc Grow Hill Education.
3. Heat Tranfer by Rajput/Mc Grow Hill Education.



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03102) MECHANICAL ENGINEERING DESIGN

### Unit 1:

Introduction: Introduction to design, the engineering model, computer aided design and Engineering, materials, load analysis, stresses, strains, deflection and stability, stress element representation for different types of loads. Locating critical sections, force flow concept, methodology for solving machine component problems. Static failure theories-failure of ductile materials, failure of brittle materials, fracture mechanics, fatigue-failure theories, surface failures.

### Unit 2:

Design synthesis: Design process and methodologies of systematic design. Conceptual design variants and evaluations. Load transmission, load equalization, light weight and rigid constructions. Machining considerations. Design of assembly and dismantling, modular constructions. Erection, operation, inspection and maintenance considerations.

### Unit 3:

Ergonomics. Design of accuracy, locating pins and registers, machining in assembly adjustment. Backlash and clearance adjustment. Problem formulation for design optimization. Examples illustrating the various principles. Available design variants for some of the common basic functional requirements. Design for Fatigue and Creep-Thermal stress fatigue – creep and rupture of metals of elevated temperature - Hydrogen embrittlement of vessel – Brittle fracture – criteria for design with defects.

### Unit 4:

Design of power transmission elements: Design of flat belts, v-belts, toothed belts, roller chains, hydrodynamic drives. Design of Gears: Spur, Helical, Bevel and Worm gears, Gear materials, forces, stresses, lubrication, design procedure considering Lewis beam strength, Buckingham dynamic load and wear load. Algorithms for the design procedure of different types of gears.

### Unit 5:

Bearings and Lubrication: Lubricants, hydrodynamic lubrication theory, design of hydrodynamic bearings, rolling element bearings, selection of rolling element bearings, bearing mountings and special bearings. Algorithms for the design procedure of bearings

(PSG Design data book is permitted in examination)



**References:**

1. Machine Design –An Integrated approach by Robert L. Norton, Prentice-Hall, 1998.
2. Mechanical Design: Theory methodology by Manjula B Waldron and Kenneth J.Waldron, Springer Verlag, New York, 1996.
3. Theory and Design of Modern Pressure Vessels by John F. Harvey, Van Nostrand Reinhold Company New York
4. Engineering Design: A materials and processing approach by George Dieter, McGraw- Hill, 1983.
5. Fundamentals of Machine Component Design by Robert C. Juvinall and Kurt M. Marshek, John Wiley & Sons, 2<sup>nd</sup> edition, 1991.
6. Product Design by Chitale, P.H.I.





---

## **CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03103) INDUSTRIAL ENGINEERING**

### **Unit I:**

Industrial Engineering: Introduction, Definition, objectives, Techniques, Functions of an Industrial Engineer, Role of IE in manufacturing and service organizations.

Productivity: Definition. Benefits, Factors influencing productivity, Partial and total productivity measures.

Plant Layout: Economics of plant location, Rural Vs Suburban sites, Types of layouts, Travel chart technique, Assembly line balancing, simple problems.

Plant Maintenance: Objectives and types.

### **Unit II:**

Production Planning and Control: Types of productions, Production cycle, Product design and development, Process planning, Loading, Scheduling, Dispatching, Routing, Progress, Control, Simple problems.

Materials Handling: Principles, Concept of unit load, Containerization, Palletization, Selection of material handling equipment, Applications of belt conveyors, Cranes, Forklift trucks in industry.

Forecasting: Factors affecting forecasting, Sources of data, Forecasting models, Forecast errors, Mean absolute deviation, Mean squared error, Tracking signal.

### **Unit III:**

Work Study: Concept of productivity, Method Study - Basic steps in method study, Process charts, Diagrams, Models and Templates, Principles of motion economy, Micro motion study, Therbligs, SIMO chart. Work Measurement - Stop watch procedure of time study, Performance rating, allowances, Work sampling, Simple problems.

### **Unit IV:**

Human factors engineering: Introduction to ergonomics and human factors - Engineering physiological basis of human performance - Biomechanics - Psychology of work and work load perception - Physical work environment - Basis of ergonomic problem identification - Safety.

Job evaluation and incentive scheme: Job description and job analysis - Job evaluation-different methods - Individual and group incentive concepts and implications - Different types of incentive schemes - Suggestion schemes

### **Unit V:**

Materials Management: Introduction, Purchasing, Objectives of purchasing department, Buying techniques, Purchase procedure, Stores and material control, Receipt and issue of materials, Store records. Inventory Control, EOQ model(Simple problems).

Statistical Quality Control – Definition, Control charts for variables and attributes. OC curve, Sampling plans, Six sigma, TQM.



**References:**

1. Principles of Management by Koontz & Donnel.
2. Production and Operations Management by Everette Adam & Ronald Ebert.
3. Operations Management by John McClain & Joseph Thames.
4. Operations Management Theory and practice by B.Mahadevan, Pearson.
5. Production and Operations Management by R.Panneerselvam, PHI
6. Industrial Engineering Management, by Dr. O. P .Khann



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03104) ADVANCED PRODUCTION TECHNOLOGY

**Unit 1:** Metal casting : Introduction- solidification of metals – fluid flow – fluidity of molten metal- Heat transfer- defects- design considerations- Economics of casting- foundry and foundry automation.

Metal casting processes: Sand casting shell moulding – expandable pattern casting - plaster mould and ceramic mould castings- investment casting – vacuum casting – permanent mould casting – slush casting – squeeze casting and semi solid metal forming.

**Unit 2:** Welding Processes: Oxy-fuel gas welding arc welding – thermit welding – electron beam welding – laser beam welding – weld quality – weld ability – testing – weld design and process selection.

Solid state welding processes: cold welding – ultrasonic welding – friction welding. Resistance welding – explosion welding – diffusion welding – super-plastic forming – adhesive joining – joining plastics thermal spraying.

**Unit 3:** Metal Cutting: Mechanics of chip formation – cutting forces – cutting power – tool life – selection of cutting tool materials and cutting fluids – machining and turning centres – machining – economics.

Advanced Machining Processes: Electro discharge machining – electro chemical grinding – electron beam machining – abrasive jet machining – nanofabrication – micromachining – rapid prototyping operations – applications.

**Unit 4:** Processing of Powders, Ceramics and Super conductors: Production, compaction, sintering of powders – design considerations – shaping of ceramics – forming and shaping of glass – processing of super conductors.

**Unit 5:** Processing of plastics and Composites: Processing methods for plastics, composites, tool making and die making for plastics, composites.

### References:

1. Manufacturing engineering and technology by Serope Kalpajian, SR Schmid.
2. Modern materials and manufacturing processes by RG Bruce, WK Dalton.



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03105) MATERIAL TECHNOLOGY

### Unit 1:

Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening.

Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non crystalline material.

### Unit 2:

Griffith's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson Miller Parameter, Deformation and Fracture mechanism maps.

### Unit 3:

Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

### Unit 4:

Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep.

Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto, Marine, Machinery and Nuclear Applications.

### Unit 5:

Modern Metallic Materials : Dual Phase Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Intermetallics, Ni and Ti Aluminides, Smart Materials, Shape Memory alloys, Metallic Glass, Quasi Crystal and Nano Crystalline Materials.

Nonmetallic Materials : Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, Structure, Properties and Applications of engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, Al<sub>2</sub>O<sub>3</sub>, SiC, Si<sub>3</sub>N<sub>4</sub>, CBN and Diamond : properties, Processing and applications.



**References:**

1. Mechanical Behaviour of by Thomas H. Courtney / 2nd Edition, McGraw Hill,2000.
2. Mechanical Metallurgy by George E. Dieter / McGraw Hill,1998.
3. Selection and use of Engineering Materials 3e/Charles J.A/ Butterworth Heiremann.



---

## **CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03106) REFRIGERATION EQUIPMENT AND CRYOGENIC ENGINEERING**

### **Unit 1:**

Compressors - types - equivalent shaft work - Volumetric efficiency - factors affecting total volumetric efficiency - compound compression with inters cooling - rotary compressors - surging - screw compressors - lubricating oils.

### **Unit 2: .**

Condensers - types -Water cooled Condensers-Air cooled, Evaporative types - Economic water rate - Economic water velocity - over all heat transfer co-efficient - design - temperature distribution and heat flow in a condenser - pressure drop - fouling factor - LMTD correction factor (no problems).

### **Unit 3:**

Cooling towers and spray ponds - classification - performance of cooling towers - analysis of counter flow cooling towers - enthalpy - temperature diagram of air and water - cooling ponds - types - cross flow cooling towers - procedure for calibration of outlet conditions.

Evaporators - types - Flooded and dry Evaporators, natural and forced convection type - shell and tube - shell and coil, plate type - secondary Evaporators - temperature distribution and heat flow in evaporator - pressure drop - fouling correction factor (no problems).

### **Unit 4:**

Expansion devices - Capillary tube, thermostatic expansion valve - float valves, externally equalized valves - automatic expansion valves - solenoid control valve - location of piping and pump design consideration.(no problems)

Performance of complete Vapour compression system-Performance of condensing unit-compressor -Evaporator-balancing of load in two stage compression.(no problems)

### **Unit 5:**

Liquification of air - Lindae system-Analysis-Dual pressure cycle analysis-Liquefaction of Hydrogen and Helium-problems. Application of Lower temperature-Effects on the properties of metals-strength-Thermal properties-super conductivity-super fluidity.

Cooling by adiabatic de-magnetization - Gas separation and cryogenic systems-separation of gases- Rectifying columns-Air separating- single and double columns Air separation plant. Storage and handling of cryogenic liquids - Dewars and other types of containers.



## References

1. Refrigeration and Air Conditioning' - by Stoecker – TMGH– International Edition,1982
2. Refrigeration and Air Conditioning' - by Domkundwar – Dhanpat Rai & Co., - 2000
3. Refrigeration and Air Conditioning' - by - C.P.Arora – TMGH – 2000
4. Cryogenics by Barron. Oxford University Press 1980.
5. Cryogenic Engineering by Timmerhaus, Springer (Oct 2006)
6. Cryogenic Engineering by Huston: McGraw Hill
7. Refrigeration and Air-conditioning by S.Domkundwar.



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03107) HEAT AND MASS TRANSFER

### Unit 1:

Unsteady state heat transfer process by conduction, governing equations and boundary conditions - Two dimensional steady state conduction, semi-infinite and finite flat plate; temperature field in infinite and finite cylinders- Numerical methods, relaxation method and finite difference methods in heat conduction - simple problems.

### Unit 2:

Heating and cooling of bodies with negligible internal resistance, sudden changes in the surface temperature of infinite plates, cylinders and semi-infinite bodies-simple problems- Forced convection in laminar flow - exact and approximate solutions of boundary layer, energy equation for plane isothermal plate in longitudinal flow - problems.

### Unit 3:

Boiling and condensation: analysis of film condensation on a vertical surface - pool boiling and forced convection boiling inside tubes – problems

### Unit 4:

Radiation network for an absorbing and transmitting medium, radiation exchange with specular surfaces, radiation exchange with transmissivity and reflecting absorbing medium. Formulation for numerical solution. Solar radiation: Radiation properties of environment, effect of radiation on temperature measurement, the radiation heat transfer coefficient, problems.

### Unit 5:

Steady state diffusion in dilute solutions in stationary media, transient diffusion in dilute solutions in stationary media, one dimensional non dilute diffusion in gases with one component stationary - Convective mass transfer - governing equations-forced diffusion from flat plate- Dimension less correlation's for mass transfer. Simultaneous heat and mass transfer - analogy between heat, mass and momentum transfer.

### References:

**Heat transfer** by J.P. Holman, International student edition

1. Fundamentals of heat and mass transfer by R.C. Sachdev New age international publishers.





---

## **CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL**

### **(20PH03108) I.C. ENGINES AND ALTERNATIVE FUELS**

#### **Unit 1:**

Introduction: Historical Review –Broad classification of fuels - Engine Types – Design and operating Parameters-Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles difference and Factors responsible for – Computer Modeling and simulation of combustion process.

#### **Unit 2:**

Gas Exchange Processes: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging. Exhaust gas recirculation system and their designing- Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows. Fuel supply systems for SI and CI engines to use gaseous fuels like LPG, CNG, and Hydrogen.

#### **Unit 3:**

Engine Combustion: Combustion and Speed – Cyclic Variations – Ignition – Abnormal combustion Fuel factors-Combustion in CI engines: Essential Features – Types of Cylinders. Pr. Data – Fuel Spray Behavior – Ignition Delay – Mixing Formation and control:

#### **Unit 4:**

Pollutant Formation and Control: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, Un-burnt Hydrocarbon and particulate emission – Measurement – Exhaust Gas Treatment. Catalytic converter, 2 way type & 3 way type.

#### **Unit 5:**

Modern Trends in IC Engines: Computer Simulation and Optimized Design -Lean Burning and Adiabatic concepts - Rotary Engines. Modification in IC Engines to suite Bio-Fuels

#### **References:**

1. I.C. Engines Fundamentals/Heywood/Mc Graw Hill
2. I.C. Engines /Ferguson/John Wiley(WE & Exclusive)
3. I.C. Engines / Maleev
4. IC Engines / V Ganesan
5. I.C. Engine in theory and Practice Vol. I and II / Taylor
6. I.C. Engines / Obert / Int.Text Book Co.
7. Combustion Engine Processes / Lichty
8. Scavenging of two stroke Cycle Engines / Switzer



---

## **CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL**

### **(20PH03109) CAD THEORY AND PRACTICE**

#### **Unit 1:**

CAD Tools: Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software.

#### **Unit 2:**

Geometric Modelling: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves B-splines rational curves

#### **Unit 3:**

Surface Modeling: Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.

#### **Unit 4:**

Parametric Representation Of Synthetic Surfaces: Hermite Bi-cubic surface, Bezier surface, B- Spline surface, COONs surface, Blending surface , Sculptured surface, Surface manipulation–Displaying, Segmentation, Trimming, Intersection, Transformations(both 2D & 3D).

Geometric Modelling-3d: Solid modeling, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).

#### **Unit 5:**

CAD/CAM data Exchange:

Evaluation of data – exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF.

Mechanical tolerances, Mass property calculations, Finite Element Modeling and Analysis and Mechanical Assembly.

Collaborative Engineering: Collaborative Design, Principles, Approaches, Tools, Design Systems.



**Text Books:**

1. CAD/CAM Theory and Practice / Ibrhim Zeid / Mc Graw Hill international.

**References:**

Mastering CAD/CAM / Ibrhim Zeid / Mc Graw Hill international.

1. CAD/CAM / P.N.Rao / TMH.
2. CAD CAM: Principles, Practice and Manufacturing Management / Chris Mc Mohan, Jimmie Browne / Pearson edu. (LPE)
3. Concurrent Engineering Fundamentals: Integrated Product Development/ Prasad / Prentice Hall, 1996.
4. Successful Implementation of Concurrent Product and Process / Sammy G Sinha / Wiley, John and Sons Inc., 1998.



---

## **CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03110) MECHANICAL VIBRATIONS AND CONDITION MONITORING**

### **Unit 1:**

Single degree freedom systems -Introduction - Single degree freedom systems - free and forced vibrations - Damping classification and damped systems. Two degree freedom systems - Free, forced damped and undamped motions - Use of influence coefficients, Matrix methods and Lagrange's equations - Phenomenon of beat - Dynamic absorbers – Applications.

### **Unit 2:**

Transient (Shock) vibrations as applied to single and two degree freedom systems - Use of mathematics and graphical techniques in the analysis (superposition integral, Laplace transformations, phase plane techniques).

### **Unit 3:**

Multi degree freedom systems - Free and forced motions in longitudinal, torsional and lateral modes - damped and undamped, critical speeds of rotors. Continuous systems - free and forced vibrations of string, bars and beams - Principle of Orthogonality Classical and energy methods by Rayleigh, Ritz and Galerkin.

### **Unit 4:**

Numerical methods in Vibration Analysis - Introduction-Reduction of Vibration at the source Control of vibration-by structural design-Material selection- Localized additions Artificial Damping- Resilient isolation, Vibration isolation, Vibration absorbers Condition monitoring methods- Introduction, the design of Information system, Selecting methods of monitoring, Machine condition monitoring and diagnosis.

### **Unit 5:**

Vibration Measurements and analysis - Transducers and mounting methods, Data acquisition using instrumentation recorders/data loggers, Time domain signal analysis, Orbit analysis, Filters, Frequency domain analysis (Narrow band FFT analysis), Nyquist criteria, sampling, aliasing, windowing and averaging. Fault Diagnosis, Interpreting vibration measurements for common machine faults, Imbalance, Misalignment, Bearing and Gearing faults, Faults in Induction motors, Resonances, Some case studies.



### References:

1. Mechanical Vibrations by A.H. Church.
2. Mechanical Vibrations Practice with Basic Theory by V.Ramamurthi, Narosa Publishing House.
3. Mechanical Vibrations by Den Hartog.
4. Mechanical Vibrations by Singiresu S. Rao, Addison Wesley Publishing Co., 1995.
5. Mechanical Vibrations by J.O. Den Hartog, Mc Graw Hill, New York, 1985.
- Vibration Condition Monitoring of Machines by Rao J.S., CRS Press, 2000.
6. Hand Book of Condition Monitoring by Science Elsevier, Elsevier Science, 1996.
7. Mechanical fault diagnosis and condition monitoring by RA Collacott (1977).
8. The Vibration Monitoring Handbook (Coxmoor's Machine & Systems Condition Monitoring) (1998).



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03111) DESIGN FOR MANUFACTURE

### Unit 1:

Introduction :Design philosophy – steps in Design process – General Design rules for manufacturability – basic principles of designing for economical production – creativity in design. Materials: Selection of Materials for design – Developments in Material technology – criteria for material selection – Material selection interrelationship with process selection – process selection charts.

### Unit 2:

Machining Process: Overview of various machining processes – general design rules for machining - Dimensional tolerance and surface roughness – Design for machining, Ease – Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

### Unit 3:

Metal Casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting – casting tolerances – use of solidification simulation in casting design – product design rules for sand casting.

Metal Joining: Appraisal of various welding processes, Factors in design of weldments – general design guidelines – pre and post treatment of welds – effects of thermal stresses in weld joints – design of brazed joints.

### Unit 4:

Forging – Design factors for Forging – Closed die forging design – parting lines of dies – drop forging die design – general design recommendations –

Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing – Keeler Goodman Forming Line Diagram – Component Design for Blanking. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing – Keeler Goodman Forming Line Diagram – Component Design for Blanking.

### Unit 5:

Plastics: Viscoelastic and creep behavior in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding – Design guidelines for machining and joining of plastics.



### References:

1. Design for Manufacture / John Cobert / Adisson Wesley, 1995.
2. ASM Handbook, Vol.20.
3. Engineering Design- A Material and Processing Approach / George E. Deiter / McGraw Hill Intl., 2<sup>nd</sup> Edition, 2000.
4. Product design and Manufacturing / A.K Chitale and R.C Gupta / Prentice – Hall of India, New Delhi, 2003.
5. Design and Manufacturing / Surender Kumar & Goutham Sutradhar / Oxford & IBH Publishing Co. Pvt .Ltd., New Delhi, 1998.



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03112) SPECIAL MANUFACTURING PROCESSES

### Unit 1:

Surface treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

### Unit 2:

Non-Traditional Machining: Introduction, need ,AJM, Parametric Analysis, Process capabilities, USM -Mechanics of cutting, models, Parametric Analysis, WJM -principle, equipment, process characteristics, performance.

### Unit 3:

EDM - principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, WEDM.  
LBM - working , equipment , PAM - working , system ,performance  
EBM - working , equipment , process parameters  
ECM - principle, equipment, mechanical properties, MRR, parameter analysis

### Unit 4:

Processing of ceramics : Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying , sintering, Hot compaction, Area of application ,finishing of ceramics.

Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

### Unit 5:

Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics.properties of nano-materials, introduction to micromachining, High Speed Machining and rapid prototyping process.

### References:

1. Manufacturing Engineering and Technology / Kalpakijian / Adisson Wesley.





2. Process and Materials of Manufacturing / R. A. Lindburg / PHI
3. Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostrand Reinhold,
4. MEMS & Micro Systems Design and manufacture / Tai - Run Hsu / TMGH
5. Advanced Machining Processes / V.K.Jain / Allied Publications.
6. Introduction to Manufacturing Processes / John A Schey / Mc Graw Hill



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03113) INDUSTRIAL ROBOTICS

### **Unit 1:**

Introduction: Robot anatomy, robot configuration, work volume, characteristics, dynamic performance, precision of movement. End effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors, consideration in gripper selection and design.

### **Unit 2:**

Motion analysis: Manipulator kinematics, Position representation, Homogeneous transformation, DH notation, Forward kinematics, Simple problems applied to different configurations up to 6 dof. Inverse kinematics, simple problems applied to different configurations up to 6 dof.

### **Unit 3:**

Differential kinematics: Differential transformations of 2 dof and 3dof manipulators, Jacobians, Problems

Robot dynamics, D' Alembers method, Newton Euler method and Lagrange Euler method, Simple problems.

Sensors: Desirable features, Internal and external sensors, Feedback components, tactile, proximity and range sensors, uses sensors in robotics.

### **Unit 4:**

Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching capabilities and Limitations.

Robot Languages: Textual robot languages, Generation, Robot language structures, Elements in function. Programming of various functions in PTP and CP system of robots with suitable examples.

### **Unit 5:**

Trajectory planning: theory and problems relating to trajectory path planning



Robot Cell Design And Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detection, Work cell controller.

Robot Applications: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application.

**References:**

1. Industrial robotics / Mikell P.Groover / McGraw Hill.
2. Robotics: control, sensing, vision, intelligence / K.S.Fu, R.U. Gonzalez, C.S.G. Lee / McGraw Hill.
3. Robotics for engineers, Yoram Koren, McGraw Hill
4. Industrial Robotics/ Ganesh S. Hegde/ University Science press



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03114) SIMULATION MODELLING AND ANALYSIS OF MANUFACTURING SYSTEMS

**Unit 1:** Introduction: History of Manufacturing Systems, Input-Output Model, plant configuration, performance measures, computer controlled machines, material handling systems, plant layout, flexible Manufacturing systems (FMS), Computer Control Systems.

Models: Model Automated Manufacturing systems, Role of performance modeling, Nature of Models, Basic approach to modeling, types of models, analytical Vs simulation models-Need for the both.

**Unit 2:** Simulation Modeling: The nature of simulation, systems models and simulation discrete event simulation, principles of valid simulation modeling, verification of simulation computer programs, general perspectives on validation, A three-step approach for developing valid and credible simulation models, Random number generators.

**Unit 3:** Markov Chain Models: Review of basic probability and statistics, Estimation of means and variances, memoryless random variables, geometric and exponential random variables stochastic process in Manufacturing, Discrete time Markov chain models, continuous time Markov chain models, Semi Markov process in manufacturing.

**Unit 4:** Queuing Models: Queues, the M/M/1 Queue, the M/M/m Queue, batch arrival queuing systems, Queues with general distributions, Queues with breakdowns, Queuing networks, Open and closed queuing networks, Queuing networks with blocking, Performability analysis.

Petrinet Models: Classical petrinets, Stochastic petrinets, Generalized stochastic petrinets (GSPN), GSPN Modeling of typical manufacturing systems.

**Unit 5:** Simulation of Manufacturing Systems: Objectives of simulation in manufacturing, simulation software for manufacturing applications, Modeling system randomness, sources of Randomness, Machine downtimes, examples.

Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs. Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages



## References:

1. "Performance Modeling of Automated manufacturing systems" by N. Viswanadham and Y. Narahari, PHI, 1994.
2. "Stochastic Models of Manufacturing Systems" John A. Buzacott, J. George and Shanthi Kumar, Prentice Hall Englewood Cliffs, USA, 1993.
3. "Simulation Modeling and Analysis" by Averill M. Law and W. David Kelton, McGraw Hill International Editions, 1997.
4. "Discrete - Event System Simulation" Jerry Banks, John S. Carson, Barry L. Nelson and David M. Nicol, Pearson Education International Series in Industrial and Systems Engineering, 2001.



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03115) ADVANCED OPTIMIZATION TECHNIQUES

### Unit 1:

Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – Solution by method of constrained variation, method of Lagrange multipliers, Kuhn- Tucker conditions.

### Unit 2:

Numerical methods for optimization: Direct search methods – Random search methods, Nelder Mead's Simplex search method, Hooke and Jeeves' method, Powell's method.

Indirect search methods: Gradient of a function, Steepest descent method, Newton's method, Davidon-Fletcher-Powell method, types of penalty methods for handling constraints.

### Unit 3:

Geometric programming (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P), Complementary Geometric Programming (C.G.P)

Dynamic programming(D.P): Multistage decision processes. Concepts of sub optimization and Principal of optimality, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P. and continuous D.P.

### Unit 4:

Integer programming(I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Branch-and-bound method, Sequential linear discrete Programming, Generalized penalty function method.

Stochastic Programming (S.P.): Basic Concepts of Probability Theory, Stochastic Linear programming.

### Unit 5:

Non-traditional optimization techniques: Multi-objective optimization - Lexicographic method, Goal programming method, Genetic algorithms, Simulated annealing, Neural Networks based Optimization.



## References:

1. Engineering Optimization – S.S.Rao, New Age Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
4. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
5. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
6. Operations Research- Principles and Practice by Ravindran, Phillips and Solberg, John Wiley
7. Introduction to Operations Research by Hiller and Lieberman, Mc Graw Hill
8. The Essence of Total Quality Management by John Bank, PHI, 1993.
9. Beyond Total Quality Management by Greg Bounds, Lyle Yorks et al, McGraw Hill, 1994.
10. The Asian Productivity Organization by Takashi Osada, 1991.
11. KAIZEN by Masaki Imami, McGraw Hill, 1986.



---

## **CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03116) LOGISTICS AND SUPPLY CHAIN MANAGEMENT**

### **Unit I:**

Logistics and Competitive Strategy: Competitive advantage – Gaining Competitive Advantage through logistic – The Mission of Logistics Management – Integrated supply chains – Supply Chain and Competitive performance – The changing logistics environment – Models in Logistics Management – Logistics to supply Chain Management – Focus areas in supply Chain Management – performance Measures for SCM.

Customer Service Dimension: The marketing and logistics interface – Customer service and customer retention - Service – driven logistics systems – Basic service capability – Increasing customer expectations – Value added services – Customer satisfaction and success – Time based logistics – Case studies.

### **Unit II:**

Logistics System Design: Logistics positioning – Logistics reengineering – reengineering procedure – logistics environmental assessment – time based logistics – alternative logistics strategies – strategic integration – logistics time based control techniques.

Measuring Logistics Costs and Performance: The concept of Total Cost analysis – Principles of logistics costing – Logistics and the bottom line – Impact of Logistics on Shareholder value – customer profitability analysis – direct product profitability – cost driver and activity – based costing.

Logistics and Supply chain relationships: Benchmarking the logistics process and SCM operation – Mapping the supply chain processes – Supplier and distributor benchmarking – setting benchmarking priorities – identifying logistics performance indicators – Channel structure – Economics of distribution – channel relationship – logistic service alliances.

### **Unit III:**

Sourcing, transporting and pricing products: Sourcing decisions in supply chain – transportation in the supply chain – transportation infrastructure – supplier of transport services – basic transportation economics and pricing – transportation documentation – pricing and revenue management in the supply chain – Coordination in the supply chain – pricing and revenue management in supply chains.

### **Unit IV:**

Coordination and Technology in Supply chain: Lack of coordination and Bullwhip Effect – Impact of lack of coordination – obstacles to coordination – managerial levers to achieve





coordination – Building strategic partners and trust within a supply chain. Role of IT in the supply chain – Customer Relationship Management – Internal supply chain management – Supply chain IT in practice – Information technology and the supply chain – E-business and the supply chain – E-business Framework – case studies.

#### **Unit V:**

Managing global logistics and global supply chains: Logistics in a global economy – views of global logistics – global operating levels – interlink global economy – The global supply chains – Global supply chain business processes – Global strategy – Global purchasing – Global logistics – Channel in Global logistics – Global alliances – Issues and Challenges in Global supply chain Management – case studies.

#### **References:**

1. Closs, Logistical Management by Donald J. Bowersox and David J. The Integrated Supply Chain Process, TMH, 2003.
2. Logistics Supply Chain Management by Martin Christopher Pitman, London 1993.
3. Supply Chain Management by Sunil Chopra and Peter Meindl Strategy, Planning and Operation, 2/e, Pearson Education, New Delhi 2002.
4. Supply Chain Management for Global competitiveness by B.S.Sahay Macmillan, NewDelhi, 2003.
5. Manageing the Global Supply Chain, Philip B.Schary, Tage Skjott – Larsen Viva, Mumbai, 2000.
6. Purchasing and Supply Chain Management- Arjun J Van Weele: Analysis, Planning and Practice, 2/e Thomson Learning, 2000.
7. Business Logistics/Supply chain management Ballou,5/e Pearson Education.



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03117) ADVANCED OPERATIONS MANAGEMENT

### Unit 1:

Product design – Requirements of good product design – product development – approaches – concepts in product development – standardization - simplification – Speed to market – Introduction to concurrent engineering. Value engineering – objective – types of values –function & cost – product life cycle – steps in value engineering – methodology in value engineers – FAST Diagram –Matrix Method.

Aggregate Planning – definition – Different Strategies – Various models of Aggregate Planning-Transportation and graphical models

### Unit 2:

Advance inventory control systems push systems –Material Requirement – Terminology – types of demands – inputs to MRP- techniques of MRP – Lot sizing methods – benefits and drawbacks of MRP – Manufacturing Resources Planning (MRP –II). Pull systems – Vs Push system – Just in time (JIT) philosophy Kanban System - Calculation of number of Kanbans Requirements for implementation JIT – JIT Production process – benefits of JIT

### Unit 3:

Scheduling: Forward and Backward Scheduling- Master Scheduling- Evaluation of Job Shop Schedules with reference to Priority Scheduling rules, Sequencing, Assignment techniques in Production Scheduling, Line of balance. Project Management – programming evaluation review techniques (PERT) – three times estimation –critical path – probability of completion of project – critical path method – crashing of simple nature.

Project Appraisal: Criteria for financial appraisal, Payback period, Net present value, Internal rate of return, Profitability index, Capital rationing and selection of projects

### Unit 4:

Total Quality Management: Philosophy of TQM, Quality Gurus, QC tools, Quality circles, Benchmarking, Strategic quality planning, Quality function deployment,

### Unit 5:

Quality system: Need for ISO 9000 system, Advantages, Clauses of ISO 9000, Implementation of ISO 9000, Quality costs, Quality auditing.

Implementation of TQM: KAIZEN, 5S, JIT, POKAYOKE, Taguchi method, 6-sigma management – models and case studies – reverse engineering – philosophies and case studies.



**Reference:**

1. Total Quality Management by Rose, J.E., Kogan Page Ltd., 1993
2. Operations Management” by E.S. Buffs., C.B. Publishers.
3. “Operations Management, Theory and Problems” by Joseph G. Monks, Mc Grow Hill book Company-Koga.
4. “Production Systems Management” by James. L. Riggs, John wiley & Sons Inc.
5. “Production and Operations Management” by Chary, TaTa Mc Grow-Hill
6. “Operation Management” by Chase, Mc Graw-Hill
7. “Production & Operation Management” by Panner Selvam PHI
8. “Production & Operation Analysis” by Nahima



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03118) MECHANICS OF COMPOSITE MATERIALS

### Unit 1:

Introduction to composite materials Definition, classification and characteristics of composite materials, Materials-fibrous composites, laminated composites, particulate composites, Basic concepts and characteristics: Geometric and Physical definitions, natural and man-made composites, applications, types and classification of composites, lamina and laminate characteristics and configurations, constituent materials and properties.

### Unit 2:

Coordinate transformations: Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off - axis, stiffness modulus, off - axis compliance. Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

### Unit 3:

Strength of unidirectional lamina: Micro mechanics of failure, Failure mechanisms, Strength of an orthotropic lamina, Strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects. Micromechanical predictions of elastic constants.

### Unit 4:

Characteristics of fiber reinforced lamina Fundamentals, elastic properties unidirectional, continuous fiber zero degree and angle ply lamina. Analysis of laminated composite plates

### Unit 5:

Applications of composites-- Advantages, disadvantages, limitations and applications of composite. Properties of typical composite materials. Introductions to shape memory alloys

### References:

1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2. Analysis and performance of fibre Composites by B. D. Agarwal and L. J. Broutman, Wiley-Interscience, New York, 1980.
3. Mechanics of Composite Materials by R. M. Jones, Mc Graw Hill Company, New York, 1975.
4. Analysis of Laminated Composite Structures by L. R. Calcote Van Nostrand Rainfold, New York, 1969.
5. Introduction to composite materials by Hull and Clyne Cambridge uNIVERSITY
6. Fiber reinforced composites P K MALLICK by Marcel Dekker , Inc



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03119) ENERGY CONSERVATION

### Unit 1:

Heat Transfer Theory: Conduction equation- thermal resistance-combined heat transfer process-heat transfer by conduction (steady state): Radial heat conduction through tubes; through spherical shells, Composite structures. General equation for forced and free convection- horizontal, vertical plates, flow in side pipe . Radiation- Steffen Boltzmann constant- configuration Factor.

### Unit 2:

Thermodynamics: Availability, energy, and Anergy-Exergy, energy, entropy relationship- Degradation of energy – exergy analysis- exergy conservation- combustion, adiabatic flame temperature, Thermal efficiency, thermal losses; thermal balance sheets.

Heat Exchanger Theory: Types of heat exchangers - overall heat transfer coefficient – fouling factor - Design of heat Exchangers, L.M.T.D. and N.T.U. methods.

### Unit 3:

Energy Conservation: Rules for efficient energy conservation – technologies for energy conservation – outline of waste heat and material reclamation, load management, alternative energy sources , Energy storage.

Design For The Conservation Of Energy & Material: Simulation & modeling – energy flow networks – critical assessment of energy usage, formulation of objectives and constraints- synthesis of alternative options – technical Analysis of option.

### Unit 4:

Thermal Insulation & Refractories: Heat loss through un insulated and insulated surfaces; effect of insulation on current carrying wires – economic thickness of insulation – critical radius of insulation – properties of thermal insulators – classification of insulation materials – classification of Refractories – properties of refractories – Criteria for good refractory material – application of insulating & refractory materials.

### Unit 5:

Waste Heat Recovery Systems: Guideline to identify waste heat – feasibility study of waste heat – shell and tube heat exchangers – Thermal wheel – heat pipe heat exchanger – Heat pump – waste heat boilers – Incinerators.

Heat Recovery Systems: Liquid to liquid heat exchangers – Gas to gas recovery systems; regenerators , recuperators , rotating regenerators – Miscellaneous heat recovery methods – selection of materials for heat exchangers – combined radiation and convective heat exchanger , U- tube heat exchanger , tubular heat exchanger , fluidized bed heat exchanger –economizer.



### References:

1. Waste heat recovery systems by D.A. Reay Pergamon press.
2. Hand book of Energy Audits by Albert Thumann.
3. Energy Management by W.R. Murphy & G. Mickay, Butterworths.
4. Energy Conservation by P.W.O. Callaghan, paragamon press 1981.
5. Engineering Heat transfer by C.P. Gupta & Rajendra prakesh , Nemchand & bros., Roorke.



---

## CHAITANYA (DEEMED TO BE UNIVERSITY) WARANGAL (20PH03120) COMPUTATIONAL METHODS

**Unit 1:** Finite differences – Forward, Backward and Central difference approximations to derivatives  
- Jacobi's Method – Gauss Siedel iterative method

Numerical solution of Partial differential Equations: Implicit method – Explicit method - ADI method  
– ADE method

**Unit 2:**

Introduction to FEM: Basic concepts – Historical background – General Applications of FEM -  
General description of the FEM – Comparison of FEM with other methods - Basic element shapes  
discretization process - Node numbering scheme – interpolation models – convergence requirements -  
Stress and equilibrium – boundary conditions – stress – strain relations

**Unit 3:**

One dimensional problem – modeling – coordinates and shape functions – Assembly of stiffness  
matrix and load vector – Properties of stiffness matrix. – Axial bar element – Temperature effects.

**Unit 4:**

Two dimensional problems – modeling – Constant strain triangle – boundary condition –Load vector  
– Quadrilateral element

Basic equation of heat transfer – steady state heat transfer – 1-D heat conduction – Fin element – 2-  
D heat transfer.

**Unit 5:**

Modeling of incompressible flows – Stream function – Vorticity equation – Upwind scheme –  
Estimation of discretisation errors

Finite volume approach – Basic rules – Linearization of source term – 1-D heat conduction – Steady  
and unsteady – Implicit method – Explicit method – Stability criteria

**References:**

1. Introduction to Numerical Methods/ S.S.Sastry, Prentice-hall of India Pvt Ltd (2007)
2. Numerical Methods /B.S.Grawel, Khanna Publication.
3. Computational Fluid flow and Heat transfer / Edt.K.Muralidhar and T.Sundarrajan / Narosa
4. Finite Elements in Engineering / S.S.Rao
5. Introduction to Finite Element Engineering/T.R.Chandrupatla and A.D. Belagundu
6. Numerical fluid flow and Heat transfer /S.V.Patank