Department of Mechanical Engineering
Andhra University College of Engineering (Autonomous)
Visakhapatnam-530 003
Andhra Pradesh, India
## I & II SEMESTERS

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(A) Refrigeration and Air Conditioning  
(B) Advanced Foundry and Welding Technology  
(C) Work Study  
(D) Power Plant Engineering  
(E) Finite Element Analysis  
(F) Computer Graphics

Elective – II:  
(A) Gas Turbines and Jet Propulsion  
(B) Automobile Engineering  
(C) Tool Design  
(D) Production Planning and Control  
(E) Robotics  
(F) Mechatronics

Elective – III:  
(A) Computational Fluid Dynamics  
(B) Non Conventional Energy Sources  
(C) Computer Numerical Control and Computer Aided Manufacturing  
(D) Total Quality Management  
(E) Optimization Design  
(F) Engineering Tribology

● Page 5     For Admitted batch of 2014-2015
### First Year

#### I & II Semesters

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ENGLISH  
(Common to all the Branches – B.E./B. Tech/Dual degree M. Tech Courses and Architecture)  

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**Vocabulary:** Word Search, Discuss and Note – Word Quiz – A List of 100 Basic Words – One Word Substitutes – 100 Difficult Words, Synonyms, Antonyms, Idioms, Technical terms

**2) Grammar:** Types of Sentences, Verbs, Adverbs, Pronouns, Adjectives, Gerunds & Infinitives, Articles, Quantifier, Punctuation, Prepositions, Conjunctions, Exclamation.


**4) Listening:** Life in a Hostel – Eating Away those Blues!, Meeting Carl Jung – A Documentary on the Big Cat – A Consultant Interviewing Employees – A Conversation about a Business Idea – An Interview with a Woman Engineer

**5) Speaking:** Your favourite Holiday Destination – Describe yourself – Why we need to Save OurTigers-a Dialogue – Your First Interview – Pair Work: Setting up a New Business – Great Engineering Achievements.


**Text Book:**


**Reference Books:**
I Partial Differentiation and its applications:
Functions of Two or More Variables, Partial Derivatives, Homogeneous Functions- Euler’s Theorem, Total Derivative, Differentiation of Implicit Functions, Geometrical Interpretation- Tangent Plane and Normal to a surface. Change of Variables, Jacobians, Taylor’s Theorem for functions of two variables, Errors and approximations. Total Differential, Maxima and Minima of functions of two variables. Lagrange’s method of undetermined multipliers, Differentiation under the integral sign – Leibnitz Rule.
II Solid geometry:
III Multiple integrals and their applications:
IV Infinite series:
V Fourier series:
Euler’s formulae, Conditions for a Fourier expansion, Functions having points of discontinuity, Change of interval, Odd and even periodic functions – Expansions of odd and even periodic functions. Half range series. Parseval’s formula, Practical Harmonic analysis.
Text Books:
Reference Books:
ENG 1003 Mathematics-II

Lectures/week = 3  
Exam=3 Hrs,  
Sessional Marks =30  
Exam. Marks = 70

I Linear Algebra:

II Ordinary Differential Equations Of First Order And Its Applications:

III Linear Differential Equations:
Higher order linear differential equations with constant coefficients. Cauchy’s and Legendre’s linear equations. Simultaneous linear equations with constant coefficients.

IV Series solutions of differential equations:
Series Solutions of ODE-Frobenius method (when x=0 is a regular singularity), Bessel’s equation, equations reducible to Bessel’s equations. Legendre Polynomials, Rodrigue’s formula, Generating function. Recurrence relations. Orthogonality relation for Bessel’s functions and Legendre Polynomials.

V Laplace transforms:

Text Books:
Reference Books:
ENG. 1004 Physics

Lectures/week = 3  
Exam=3 Hrs,  
Sessional Marks =30  
Exam. Marks = 70

Thermodynamics

Electromagnetism
Concept of electric field – Point charge in electric field, dipole in an electric field. Gauss law, some applications, electric potential and field strength, potential due to a point charge and dipole.
Magnetic field – magnetic force on current, torque on current loop, Hall effect, Ampere’s law, B near a long wire, B for a solenoid and Toroid. The Biot-Savart,s Law. B for a circular Current loop.

Optics
Diffraction – Single slit (Qualitative and quantitative treatment).
Polarisation – Polarisation by reflection, refraction and double refraction in uniaxial crystals, Nicol prism, Quarter and Half wave plate, circular and elliptical polarization and detection.

Lasers and Fibre Optics
Spontaneous and stimulated emissions, population inversions, Ruby laser, Gas laser, Semiconductor laser, Applications of lasers.
Fibre Optics, Optical Fibre and Total Internal Reflection, Acceptance Angle and cone of a fibre, Fibre optics in communications, Optical parts in Fibre. Fibre Optic Sensors.

Ultrasonics
Production of Ultrasonics by Magnetostriction and Piezoelectric effects – Ultrasonics and diffraction pattern, Applications of Ultrasonics.

Modern Physics
The quantization of energy, Photoelectric effect, De Broglie concept of matter waves, uncertainty principle, Schrodinger wave equation, application to a particle in a box.
Elementary concepts of Maxwell-Boltzman, Bose-Einstein’s and Fermi Dirac Statistics. Fermi Dirac Distribution function (no derivations). 
Free electron theory of metals, Band theory of solids, Kronig Penny Model, Metals, Insulators and Semiconductors. Ferroelectrics and their applications
Super conductivity, Meisner Effect, Types of Superconductors and Applications of Superconductors.

Nanophase materials – Synthesis, characterization of nanostructured materials, properties and applications.
Renewable energies – Solar, wind and tidal – Applications

Books Recommended
2. Physics by David Halliday and Robert Resnick – Part I and Part II
3. Modern Engineering Physics by A.S. Vadudeva
4. University Physics by Young and Freedman
5. Materials Science by V. Rajendra and A. Marikani
6. Nonconventional Energy by Ashoke V. Desai
ENG 1005 Chemistry

Lectures/week = 3
Exam=3 Hrs,

Sessional Marks =30
Exam. Marks = 70

1. Water Chemistry and pollution:
Water pollution: Source – BOD – COD – Sewage treatment - preliminary, primary, secondary and tertiary.
Air Pollution: Source – Air pollutants – CO, Sox, NOx, Hydrocarbons and particulates. Acid rain – Green House effect – control of Air pollution (General).

2. Solid State Chemistry:

Energy Sources:
Nuclear Energy: Fission and fusion – power reactors – Atomic pile applications.

3. Corrosion Chemistry :

4. Fuels and Lubricants:
Lubricants: Classification - mechanism - properties of lubricating oils - Selection of lubricants for Engineering applications.

5. Polymers and Plastics:

6. Building Materials:
Refractories: Classifications - properties - Engineering applications.
Ceramics: Classification - Properties - uses.

Prescribed Text Books
5. Material Science and Engineering V. Raghavan - Prentice-Hall India Ltd.,

Page 11
For Admitted batch of 2014-2015
1. Historical Perspective:

2. Polices and Plans After Independence:
Nehru’s vision of Science for Independent India, Science and Technology Developments in the New Era Science and Technology Developments during the Five Year Plan Periods and Science and Technology Policy Resolutions.

3. Research and Development (R&D) in India:

4. Science and Technological Developments in Major Areas:
Space – Objectives of Space Programmes, Geostationary Satellite Services – INSAT System and INSAT Services Remote Sensing Applications, Launch Vehicle Technology
Defense Research --- Spin-off Technologies for Civilian Use;
Biotechnology--Applications of Biotechnology in – Medicine, Biocatalysts, Agriculture, Food, Fuel and Fodder, Development of Biosensors and Animal Husbandry;

5. Nexus between Technology Transfer and Development:
Transfer of Technology—Types, Methods, Mechanisms, Process, Channels and Techniques: Appropriate Technology, Technology Assessment, Technological Forecasting, Technological Innovations and Barriers of Technological Change.

Test Books:
1. Kalpana Rajaram , Science and Technology in India, Published and Distributed by Spectrum Books (P) Ltd., New Delhi-58.

Reference Books:

ENG 1006 History of Science and Technology

Lectures/week = 3
Exam=3 Hrs,

Sessional Marks =30
Exam. Marks = 70

For Admitted batch of 2014-2015
ENG 1007 Computer Programming and Numerical Methods

Lectures/week = 3  Sessional Marks = 30
Exam=3 Hrs,  Exam. Marks = 70

Objectives:
To make the student familiar with programming in C and enable the student to implement the numerical methods described in this course using C as Programming Language.

Section A

Computer Programming in C
Functions: Concept of a function – Parameters and how they are passed – Automatic Variables – Recursion – Scope and extent of variables. Writing programs using recursive and non-recursive functions.
Arrays and Strings: Single and multidimensional arrays-Character array as a string- Functions on strings. Writing C Programmes using arrays and for string manipulation.
Structures: Declaring and using structures-Operations on structures – Arrays of structures-User defined data types-Pointers to using files.

Section B

Computer Oriented Numerical Methods
2. Representation for Characters and Numbers: Representation for integer and real numbers. Effect of finite representation on arithmatic operations for example overflow, underflow, associativity and normalization. Some elementary methods for overcoming these limitations.
4. Solutions of simultaneous Algebraic Equations; Gauss elimination method and Gauss Seidal methods.
5. Interpolation: Lagrange’s Interpolation and difference table methods.

Books:
1. Section A: Programming with C by K.R. Venugopal & Sudeep R Prasad
2. Section B: Introduction to Numerical Methods by S.S Sastry
3. Elementary Numerical Methods by S.D.Conte

Reference:
1. C Programming Language by Kerningham & Ritchie
ENG 1008 Engineering Graphics

Lectures/week = 2+4
Exam=3 Hrs,

Sessional Marks =30
Exam. Marks = 70

Introduction:
Drawing Instruments and uses. Lettering scales in common use.

Curves:
Curves used in Engineering Practice, conic sections, construction of conics by different methods, rectangular-hyperbola, cycloidal curves, trochoids, epi and hypo-cycloids. involutes and Archemedian spiral.

Orthographic Projections:
Projection of points, projection of straight lines, traces of a line, projection of planes and projection on auxiliary planes.

Solids and Developments:
Projection of solids in simple positions, projection of solids with axis inclined to one of the reference planes and parallel to the other, projection of solids with axis inclined to both the reference planes. Projection of spheres. Development of surfaces of solids. Development of transition piece connecting a square and circular pipe. Helices and screw threads.

Sections and Intersections:
Sections of different solids and true shape of sections. Intersection of surfaces-simple problems with cylinders, prisms and cones.

Isometric and Perspective Projections:

Textbook:
1. Elements of Engineering Drawing by N.D. Bhatt

Reference:
12 of the following experiments must be completed:
1. Lee’s method - determination of coefficient of thermal conductivity of a bad conductor
2. Melde’s experiment - determination of the frequency of an electrically maintained tuning fork.
4. Diffraction grating - determination of wavelengths in mercury line spectrum using spectrometer
5. Determination of Cauchy’s constants using Spectrometer and mercury light.
6. Wedge method - det. of thickness of a paper by forming parallel interference fringes.
7. Michelson’s interferometer - a) det. of wavelength of light b) Resolution of spectral lines.
8. Det. of ‘μ’ using calcite crystal.
9. Optical Bench - a) Young’s double slit b) Lloyd’s mirror c) biprism d) diffraction at an edge e) Thickness of wire
11. Variation of magnetic field along the axis of current carrying circular coil - Stewart and Gee’s apparatus
12. Calibration of voltmeter using potentiometer
13. Carey Foster’s bridge a) laws of resistance b) temperature coefficient of resistance
15. Calendar and Barnes method - determination of specific heat of water
16. Hall effect – a) Determination of hall coefficient B) determination of charge density
17. Photoelectric effect – a) characteristics of photoelectric cell b) det. of Planck’s const.
18. Determination of Rydberg constant using hydrogen discharge tube
19. Determination of e/m of am electron – Thomson’s method
ENG 1010 Chemistry Laboratory

Practicals/week = 3
Exam=3 Hrs,

Sessional Marks =50
Exam. Marks = 50

List of Experiments:

01. Determination of Sodium Carbonate.
02. Determination of Sulfuric acid using a strong base.
03. Estimation of Iron (II) using Potassium Permanganate.
05. Determination of volume strength of Hydrogen Peroxide.
06. Estimation of Calcium in a sample of Portland cement.
07. Estimation of Chromium (VI) using Ferrous Ammonium Sulphate.
08. Estimation of Copper (II) using Sodium thiosulphate.
09. Analysis of Bleaching powder for Chlorine content.
11. Determination of hardness of a water sample (EDTA Method).
12. Determination of alkalinity of a water sample.

Demonstration Experiments:

14. Preparation of Copper pigment.
15. Preparation of Phenol-Formaldehyde resin.
17. Digital potentiometer.
1. **Carpentry:**
   Bench work, tools used in carpentry. Jobs for class work – half lap joint, mortise and tenon joint, half lap dovetail joint, corner dovetail joint, bridle joint.

2. **Sheet Metal:**
   Tools used in sheet metal work. Laying developments of sheet metal jobs, soldering. Jobs for class work – square tray, taper side tray, funnel, elbow pipe.

3. **Fitting:**
   Tools used in fitting work. Different files, chisels, hammers and bench vice. Jobs for class work – hexagon, rectangular, circular and triangular fits. External and internal threads with dies and taps.

**Reference:**
1. Elements of Workshop technology, Vol.1 by S.K. and H.K. Hajra Choudary
1. Write a program to read x, y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?

2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (e.g. for, while, and do while)

3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position. Copying one string to another, Reversing a string, adding one string to another.

4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, int., long, float and double. What happens when you add 1 to the largest possible integer number that can be stored?

5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.

6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).

7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their mean and standard deviation.

8. Given two points on the surface of the sphere, Write a program to determine the smallest arc length between them.

9. Implement bisection method to find the square root of a given number to a given accuracy.

10. Implement Newton Raphson method to det. a root of polynomial equation.

11. Given a table of x and corresponding f(x) values, write a program which will determine f(x) value at an intermediate x value using Lagrange’s interpolation.

12. Write a function which will invert a matrix.

13. Implement Simpson’s rule for numerical integration.


15. Write a program to solve a set of linear algebraic equations.
## II YEAR
### FIRST SEMESTER

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B.E. (MECH.) - II/IV  
(I-SEMESTER)  
MEC 211 - MATHEMATICS-III  
(Effective from the batch admitted during 2006-2007- Credit System)  

Periods/week: 5 Th   
Ses: 30   
Exam: 70   
Credits: 4   

(Common for ALL branches except Chemical Engineering)  

UNIT –I: VECTOR CALCULUS:  
Differentiation of Vectors, Curves in Space, Velocity and acceleration, relative velocity and  
amutation, scalar and vector point functions, vector operator. \( \nabla \) applied to scalar point functions-  
gradient, \( \nabla \) applied to point functions, divergence and curl. physical interpretations of \( \nabla f \), \( \nabla \cdot F \)  
and \( \nabla \times F \), \( \nabla \) applied twice to point functions, \( \nabla \) applied to products of point functions; Irrational  
and solenoidal fields  
Integration of vectors, line integral, circulation, work done, surface integral-flux, Green’s theorem in  
the plane, Stoke’s theorem, volume integral, divergence theorem.  
Introduction of orthogonal curvilinear coordinates, cylindrical and spherical polar coordinates.  

UNIT –II: INTRODUCTION OF PARTIAL DIFFERENTIAL EQUATIONS:  
Formation of partial differential equations, solutions of partial differential equations - equations  
solvable by direct integration, linear equations of first order: Lagrange’s linear equation, non-linear  
equations of first order, Charpit’s method.  
Homogeneous linear equations with constant coefficients- rules for finding the complimentary  
function, rules for finding the particular integral (working procedure), non - homogeneous linear  
equations.  

UNIT –III: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS:  
Method of separation of variables, one dimensional wave equation-vibrations of a stretched string,  
one dimensional Heat equation, two dimensional heat flow in steady state - solution of Laplace’s  
equation in Cartesian and polar co-ordinates (two dimensional).  

UNIT –IV: INTEGRAL TRANSFORMS:  
Introduction, definition, Fourier Integral, Sine and Cosine Integrals, Complex forms of Fourier  
Integral, Fourier Transform, Fourier Sine and Cosine Transforms, Finite Fourier Sine and Cosine  
Transforms.  Properties of Fouriers Transforms, Convolution Theorem for Fourier Transforms,  
Parseval’s Identity for Fourier’s Transforms, Fourier Transforms of the derivatives of a function,  
simple applications to boundary value problems.  

TEXT BOOK:  
1. Scope and treatment as in “Higher Engineering Mathematics”, by B.S. Grewal, 42nd edition,  
Khanna Publishers.  

REFERENCES:  

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For Admitted batch of 2014-2015
MEC 212 - ENGINEERING MECHANICS
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th Ses: 30 Exams: 70
Examination (Theory): 3hrs. Credits: 4

STATICS


Concurrent Forces and Parallel Forces in a Plane: Principles of statics- Equilibrium of concurrent forces in a plane- Method of projections- Equilibrium of three forces in a plane-Method of moments-

Friction. Two parallel forces- General case of parallel forces in a plane-Centre of parallel forces and centre of gravity- Centroids of composite plane figures and curves- Distributed force in a plane.

General Case of Forces in a Plane: Composition of forces in a plane- Equilibrium of forces in a plane- Plane trusses, Funicular polygon, Maxwell diagrams, method of joints, method of sections- Plane frame- method of members, Distributed force in a plane- Flexible suspension cables.

Force Systems in Space: Concurrent forces in space; method of projections, method of moments; Couples in space- Parallel forces in space- Centre of parallel forces and centre of gravity- General case of forces in space.

Principle of Virtual Work: Equilibrium of ideal systems- Efficiency of simple machines-Stable and unstable equilibrium.

DYNAMICS

Basic concepts: Kinematics- Kinetics- Newton laws of motion- Particle- Rigid body- Path of particle.

Rectilinear Translation: Kinematics of rectilinear motion Principles of dynamics- Differential equation of rectilinear motion- Motion of a particle acted upon by a constant force, Force as a function of time- Force proportional to displacement; free vibrations- D’Alembert’s principle- Momentum and impulse- Work and energy- Ideal systems: conservation of energy.

Curvilinear Translation: Kinematics of curvilinear motion- Differential equations of curvilinear- Motion of a projectile- D’Alembert’s principle- Moment of momentum- work and energy in curvilinear motion.

Rotation of rigid body about a fixed axis: Kinematics of rotation- Equation of motion for a rigid body rotating about a fixed axis- Rotation under the action of a constant moment

Torsional vibration- The compound pendulum- General case of moment proportional to angle of rotation- D’Alembert’s principle in rotation.

Plane Motion of a Rigid Body: Kinematics of plane motion- Instantaneous center- Equations of plane motion- D’Alembert’s principle in plane motion- The principle of angular momentum in plane motion- Energy equation for plane motion.

Text Book:

References:
MEC 213 – MECHANICS OF SOLIDS-I
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th
Ses: 30 Exam: 70
Examination (Theory): 3hrs.
Credits: 4

Simple Stresses: Stress, Strain, Stress-Strain curve, Lateral strain, Relationship between elastic constants, Bars of varying cross-section, Compound bars, Temperature stresses in bars. Complex Stresses: Stresses on an inclined plane under different uniaxial and biaxial stress conditions, Principal planes and principal stresses, Mohr’s circle, Relation between elastic constants, Strain energy, Impact loading.

Bending Moments and Shear Forces: Beam - Types of loads, Types of supports, S.F. and B.M. diagrams for cantilever, Simply supported and over hanging beams.

Stresses in Beams: Theory of bending, Flexural formula, Shear stresses in beams.

Deflections of Beams: Relation between curvature, slope and deflection, double integration method, Macaulay’s method, Moment area method.

Torsional Stresses in Shafts and Springs: Analysis of torsional stresses, Power transmitted, Combined bending and torsion, Closed and open coiled helical springs. Laminated springs.

Theories of Failure: Application to design of shafts.

Cylinders and Spherical Shells: Stresses and strains in thin cylinders, Thin spherical shell.

Text Book:

Reference:
1. Strength of Materials, by Timoshenko
MEC 214 - ENGINEERING THERMODYNAMICS-I
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th  Ses: 30  Exam: 70  Credits: 4

Examination (Theory): 3hrs.

Introduction: Basic concepts; Thermodynamic systems; Micro & Macro systems; Homogeneous and heterogeneous systems; Concept of continuum; Pure substance; Thermodynamic equilibrium; State; Property; Path; Process; Reversible and irreversible cycles; Work; Heat; Point function; Path function; Heat transfer.

Zeroth law of thermodynamics: Concept of equality of temperatures- Joule’s experiments-First law of thermodynamics- Isolated systems and steady flow systems- Specific heats at constant volume and pressure - Enthalpy- First law applied to flow systems- Systems undergoing a cycle and change of state- First law applied to steady flow processes-Limitations of first law of thermodynamics.

Perfect gas laws: Equation of state- Universal gas constant, various non-flow processes-Properties of end states- Heat transfer and work transfer- Change in internal energy-throttling and free expansion-Flow processes- Deviations from perfect gas model-Vanderwall’s equation of state- Compressibility charts- Variable specific heats.


Air standard cycles: Air standard efficiency- Otto cycle-Diesel cycle- Dual cycle- Brayton cycle- Atkinson cycle- Stirling cycle- Erickson cycle

Text Books:
3. Engineering Thermodynamics by K. Ramakrishna, Anuradha agencies.

References Books:
5. Engineering Thermodynamics by Zemansky.
MEC 215 – MACHINE DRAWING
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 4 Drawing
Examination: 3hrs.

Ses: 30 Exam: 70
Credits: 4

(Common to Mechanical and MPIE)

Screw threads and Screw Fastenings using standard Empirical formulae.
Riveted joints, Keys, Cotter-joints, Pin-joints.
Shaft couplings: Box and split muff couplings, Flanged, Flexible, Universal and Oldham couplings,
shaft bearings, Brackets and Hangers, Pipe joints.
Orthogonal views and Sectional views of machine parts.
Assembly drawing of various engine components and machine tool components.

Text Books:

Reference:
MEC 216 - MANUFACTURING TECHNOLOGY-I
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th
Examination (Theory): 3hrs.
Ses.: 30 Exam: 70
Credits: 4

Manufacturing concepts: Product cycle; Job, batch and mass production; Primary and secondary manufacturing processes; Principle of metal casting; Terminology; Pattern; Types; Allowances; Materials; Core boxes; Selection; Testing and preparation of moulding sands; Moulding tools and equipment; Machine moulding; Core making; Sprue; Runner, gates and risers; Types and designing; Melting and pouring the metal; Shell mold casting; Investment casting; Permanent mould casting; Casting defects.

Formability of metals: Cold and hot working; Rolling; Types; Roll size; Stretch forming, metal spinning, embossing and coining; Peening; Sheet metal forming operations; Presses; Die design.

Forging materials: Forging processes; Forging techniques; Forging presses; Forging pressure distribution and forging force; Automation of forging; Swaging; Drawing; Extrusion; High energy rate forming.

Weldability: Welding metallurgy; Principles and processes of arc welding (SMAW, GTAW, GMAW, FCAW, PAW, SAW); Welding equipment; Weld positioners and fixtures; Oxyacetylene welding; Flame cutting; Brazing and soldering; Principle of resistance welding; Types of resistance welds; Seam welding; Projection welding; Resistance butt welding; Solid state welding; Weld inspection and testing.

Text Book:

Reference Books:
3. Principles of Metal Casting by Hein and Rosenthol, Tata Mc-Graw Hill India.
MEC 217 - STRENGTH OF MATERIALS LAB
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 3 Lab
Examination: 3hrs.

Ses: 50  Exam: 50
Credits: 2

List of Experiments:
1. To study the stress strain characteristics (tension and compression) of metals by using UTM.
2. To study the stress strain characteristics of metals by using Hounsefield Tensometer.
3. Determination of compression strength of wood.
4. Determination of hardness using different hardness testing machines- Brinnels, Vickers and Rockwell’s.
5. Impact test by using Izod and Charpy methods.
6. Deflection test on beams using UTM.
7. Tension shear test on M.S. Rods.
8. To find stiffness and modulus of rigidity by conducting compression tests on springs.
9. Torsion tests on circular shafts.
11. Punch shear test, hardness test and compression test by using Hounsefield tensometer.
12. Sieve Analysis and determination of fineness number.
MEC 218 - MECHANICAL ENGINEERING LAB – I
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 3 Lab
Examination: 3hrs.
Ses: 50 Exam: 50
Credits: 2

List of Experiments:
1. Study and valve timing diagrams for four-stroke and study & PTD of two-stroke engines.
2. Determination of volumetric efficiency of the given air compressor by (i) plate orifice method and (ii) tank capacity method.
3. Calibration of the given pressure gauge.
4. a) Determination of flash and fire points and b) Canradsons carbon residue test.
5. Determination of calorific value of flues (solid, liquid and gaseous) by Bomb calorimeter/Gas calorimeter.
6. Determination of the kinematic and absolute viscosity of the given sample oils.
7. Determination of inertia of the given flywheel and connecting rod.
8. Determination of modulus of rigidity of the given wire with torsion pendulum.
9. Study of boilers, various mountings and accessories.
10. Assembling of the given two-stroke petrol engine. (Instead of engine, any mechanical unit can be given for this experiment.)
MEC 219 - Human Values & Professional Ethics
(Effective from the batch admitted during 2013-2014 - Credit System)

Total Periods: 30 Th
Examination (Theory): 3hrs
Ses. : 100
Credits : 2
Pass. Mark: 40

UNIT_I: Ethical Theories

- Basic Moral Theories:
  i) Beneficence: doing good to others
  ii) Non-violence or peace
  iii) Justice

UNIT-II

- Classification of Ethical Theories:
  i) Consequentialism–Mill’s utilitarianism- greatest happiness to greatest number of people.
  ii) Deontology-Kantianism- Actions must satisfy the categorical imperative.
  iii) Virtue theory-Aristotelianism virtue is a mean between two extremes of action or passion.

UNIT-III

- Rights & Responsibilities of a citizen:
  i) Fundamental duties as stipulated in the constitution of India.
  ii) The rights to individuals guaranteed by Indian constitution.
  iii) (a) Rights of a professional
       (b) Professional responsibilities.

UNIT-IV

- Human Values & Attitudes:
  i) Classification of Values
  ii) Analysis of desirable values
  iii) The importance of attitudes in personal & Professional lives.

UNIT-V

- Ethical Living:
  i) Maslow’s theory of Hierarchy of needs.
  ii) Clayton Alderfer’s ERG (Existence, Relatedness and Growth) theory.
  iii) Concept of harmony in life.

### B.E. (MECH.) - II/IV
#### (II-SEMESTER)

<table>
<thead>
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<th>Name of the subject</th>
<th>Periods per week</th>
<th>Max. marks</th>
<th>Credits</th>
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<td>Mathematics – IV</td>
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<td>MEC 222</td>
<td>Material Science</td>
<td>5</td>
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<td>MEC 223</td>
<td>Environmental Sciences</td>
<td>5</td>
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<td>MEC 224</td>
<td>Electrical Technology</td>
<td>5</td>
<td>70</td>
<td>30</td>
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<tr>
<td>MEC 225</td>
<td>Theory of Machines-I</td>
<td>5</td>
<td>70</td>
<td>30</td>
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<tr>
<td>MEC 226</td>
<td>Manufacturing Technology – II</td>
<td>5</td>
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<td>MEC 227</td>
<td>Manufacturing Technology Lab– I</td>
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<td>MEC 228</td>
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MEC 221 - MATHEMATICS-IV
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th  
Ses. : 30 Exam: 70
Examination (Theory): 3hrs.  
Credits: 4

(Common for ALL braches except Chemical Engineering)

I. FUNCTIONS OF A COMPLEX VARIABLE:
Continuity concept of f(z), Derivative of f(z), Cauchy-Riemann Equations, Analytic function, 
Harmonic Functions, Orthogonal systems, Applications to flow problems, Integration of complex 
functions - Cauchy’s theorem, Cauchy’s integral formula, Taylor’s and Laurent’s series without 
proofs, singular points, Residues and Calculations of residues, Cauchy’s Residue Theorem, 
Evaluation of real definite integrals (integration around Unit circle, semi circle, rectangular Contour 
and countours having poles on real axes).
Geometric representation of f(z), conformal transformation, some standard transformations: (1)w = 
z+c, (2) w=1/z, (3) w=cz(4) Bilinear transformation.
Special Standard transformations (iv) w=z² and w=ez².

II. STATISTICAL METHODS:
Random variable, Discrete probability distribution, expectation, repeated trails, Binomial distribution, 
Poisson distribution, Continuous probability distributions – Normal distribution.
Sampling Theory:
Sampling distribution, standard error, Testing of hypothesis, Level of significance, Confidence limits, 
Simple sampling of attributes, sampling of variables–large samples, and small samples, Student’s t-
distribution, χ²-distribution, F-distribution, Fisher’s Z-distribution.

III. DIFFERENCE EQUATIONS AND Z-TRANSFORMS:
Finite difference equations – definition, order and solution of difference equations, formation of 
difference equations, linear difference equations, rules for finding complementary function, rules for 
finding particular integral, simultaneous difference equations with constant coefficients.
Z-transforms- definition, some standard Z-transforms, Linear property, DAMpling rule, some standard 
results, shifting rules, initial and final value theorems, Convolution theorem, Evaluation of inverse 
transforms, applications of Z-transform to difference equations.

TEXT BOOK:
1. Scope and treatment as in “Higher Engineering Mathematics”, by B.S. Grewal, 42nd edition, 
Khanna Publishers.

REFERENCES:
MEC 222 – MATERIALS SCIENCE
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th
Examination (Theory): 3hrs.

Ses.: 30  Exam: 70
Credits: 4

Space Lattice and unit cells, crystal systems. Indices for planes and directions. Structures of common metallic materials. Crystal defects: point, line and surface defects.


NDT Testing: Ultrasonic, Magnetic, Dye penetrant and visual methods and applications radiographic.

Text Books:
1. Material Science and Engineering by V. Raghavan.

Reference Books:
MEC 223 – ENVIRONMENTAL SCIENCE
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 3 Th  Exam: 70
Examination (Theory): 3hrs.  Credits: 4
(Common to ALL branches)

Module 1: Introduction
Definition, Score and importance, Measuring and defining environmental development:
- Indicators

Module 2: Ecosystems
Introduction, Types, Characteristic features, Structure and functions of ecosystems, Forest,
Grassland, Desert, Aquatic (lakes, rivers and estuaries).

Module 3: Environment and Natural Resources Management
Land Resources: Land as a resource, Common property resources, land degradation,
Sorerosion and desertification, Effects of modern agriculture, fertilizer-pesticide problems, Forest
Resources: Use and over-exploitation, Mining and dams – their effects on forest and tribal people,
Water resources: Use and over-utilization of surface and ground water, Floods, Droughts, Water
logging and salinity, Dams – benefits and costs, Conflicts over water, Energy Resources: Energy
needs, Renewable and non-renewable energy sources, Use of alternate energy resources, Impact of
energy use on environment.

Module 4: Bio-Diversity and its Conservation
Value of bio-diversity – Consumptive and productive use, Social, Ethical, Aesthetic and
option values, Bio-geographical classification of India – India as a mega diversity habitat, Threats to
biodiversity – Hot-sports, habitat loss, poaching of wildlife, loss of species, seeds etc., Conservation
of biodiversity – in – situ and ex-situ conservation.

Module 5: Environmental Pollution – Local and Global Issues
Causes, Effects and control measures of: Air pollution, Indoor air pollution, Water pollution,
Soil pollution, Marine pollution, Noise pollution, Solid waste management, Compositing,
Vermiculture, Urban and industrial wastes, Recycling and re-use, Nature of thermal pollution and
nuclear hazards, Global warming, Acid rain, Ozone depletion.

Module 6: Environmental Problems in India
Drinking water, Sanitation and public health, Effect of activities of the quality of
environment: Urbanization, Transportation, Industrialization, Green revolution, Water scarcity and
ground water depletion, Controversies on major dams – Resettlement and rehabilitation of people
problems and concerns, Rain water harvesting, Cloud seeding and watershed management.

Module 7: Economy and Environment
The economy and environment interaction, Economics of development, Preservation and
conservation, Sustainability: Theory and practice, Limits to growth, Equitable use of resources for
sustainable lifestyles, Environmental impact assessment.

Module 8: Social Issues and the Environment
Population growth and environment, Environmental education, Environmental movements,
Environment Vs development.

Module 9: Institutions and Governance
Regulation by Government, Monitoring and enforcement of environmental regulation,
Environmental acts: Water (Prevention and control of pollution) act, air (Prevention and control of
pollution) act, Environmental Protection Act, Wild life protection act, Forest conservation act, Costal
zone regulations, Institutions and policies relating to India, Environmental Governance.
Module 10: International Conventions

Module 11: Case Studies
Chipko movement, Narmada bachao andolan, Silent valley project, Madhura refinery and Taj Majal, Industrialization of pattancheru, Nuclear reactor at Nagarjuna Sager, Tehri Dam, Ralegaon Siddhi (Anna Hazare), Kolleru lake – Acquaculture, Florosis in Andhra Pradesh.

Module 12: Field Work
Visit to a local area to document and mapping environmental assets – River / forest/ grassland / hill / mountain, Study of local environment – Common plants, Insects, Birds, Study of simple ecosystems – Pond, river, hill, slopes etc. Visits to industries, Water treatment plants, Affluent treatment plants.

Textbooks: Kaushik – Kaushik, Anubha

MEC 224 – ELECTRICAL TECHNOLOGY
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week : 5 Th  Exam : 70
Ses. : 30  Credits : 4
Examination (Theory): 3hrs.

Magnetic Circuits: Definitions of magnetic circuit, Reluctance, Magnetomotive force (m.m.f), Magnetic flux, Simple problems on magnetic circuits, Hysteresis loss.


Alternator: Alternator working principle, E.M.F. equation of alternator, Voltage regulation by sync, impedance method.


Text Book:
1. Elements of Electrical Engineering and Electronics by V.K. Mehta, S. Chand & Co.

Reference:
1. A First Course in Electrical Engineering by Kothari.
MEC 225 – THEORY OF MACHINES–I
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week : 5 Th  Exam : 70
Ses. : 30  Credits : 4

Examination (Theory): 3hrs.

Mechanisms and Machines: Introduction; Mechanism and machine; Rigid and resistant bodies; Link; Kinematic pair; Degrees of freedom; Classification of kinematic pairs; Kinematic chain; Linkage, mechanism and structure; Mobility of mechanisms; The four-bar chain; Mechanical advantage; Transmission angle; The slider-crank chain; Double slider-crank chain; Miscellaneous mechanisms.

Velocity Analysis: Introduction; Absolute and relative motions; Vectors; Additional and subtraction of vectors; Motion of a link; Four-link mechanism; Velocity images; Angular velocity of links; Velocity of rubbing; Slider-crank mechanism; Crank and slotted lever mechanism; Algebraic methods; Instantaneous center (I-center); Kennedy’s theorem; Locating I-centers; Angular velocity ratio theorem; centrode.

Acceleration Analysis: Introduction; Acceleration; Four-link mechanism; Four-link mechanism; Acceleration of intermediate and offset points; Slider-crank mechanism; Coriolis acceleration component; Crank and slotted lever mechanism; Algebraic methods; Klein’s construction; Velocity and acceleration from displacement-time curve.

Lower Pairs: Introduction; Pantograph; Straight line mechanisms; Engine indicators; Automobile steering gears; Types of steering gears; Hooke’s joint; Double Hooke’s joint.

Friction: Introduction; Kinds of friction; Laws of friction; Coefficient of friction; Inclined plane; Screw threads; Wedge; Pivots and collars; Friction clutches; Rolling friction; Antifriction bearings; Greasy friction; Greasy friction at a journal; Friction axis of a link; Film friction; Mitchell thrust bearing.

Dynamic Force Analysis: Introduction; D’Alembert’s principle; Equivalent offset inertia force; Dynamic analysis of four-link mechanism; Dynamic analysis of slider-crank mechanism; Velocity and acceleration of piston; Angular velocity and angular acceleration of connecting rod; Engine force analysis; Turning moment on crankshaft; Dynamically equivalent system; Inertia of the connecting rod; Inertia force in reciprocating engines (Graphical method); Turning-moment diagrams; Fluctuations of energy; Flywheels.

Governors: Introduction; Types of governors; Wait governor (simple conical governor); Porter governor; Proell governor; Hartnell governor; Hartung governor; Wilson-Hartnell governor (radial-spring governor); Pickering governor; Spring-controlled gravity governor; Inertia governor; Sensitiveness of a governor; Hunting; Isochronism; Stability; Effort of a governor; Power of a governor; Controlling force.

Text Book:

Reference books:
1. Theory of Machines by Thomas Bevan.
2. Theory of Machines by S.S. Rattan.
MEC 226 - MANUFACTURING TECHNOLOGY-II
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week : 5 Th        Ses. : 30        Exam : 70
Examination (Theory): 3hrs.    Credits : 4

Mechanics of Metal Cutting: Chip formation & Types; Machinability; Tool materials; Tool geometry and tool signature ASA&ISO systems; Tool wear and tool life; Cutting forces and power; Measurement of forces and temperatures; Metal cutting economics; Cutting fluids.

Engine lathe; Operations; Turret and capstan lathes; Turning center; Boring machine and operations; Shaper, planner and slotter; Types; Operations; Mechanisms.

Drill geometry and cutting actions: Special drills; Drill forces and power-drilling speeds & feeds; Torque & thrust calculation; Drilling machines; Features and operations; Milling process; Milling cutting geometry; Cutting speed, feed, time and power in milling; Types of milling machines; Machining center; Broaching; Types; Tools; Machines; Broach time.

Principle; Operations; Grinding wheel manufacturing and marking balancing; Truing and dressing of grinding wheel; Grinding wheel selection; Grinding force; Grinding machines.

Abrasie belt machining: Lapping, honing and super finishing; Electro polishing and buffing.

Equipment; Process; Characteristics; Advantages; Limitations; Applications of chemical milling; Photochemical milling; EDM-computer controlled-traveling wire; ECM; AJM; LBM; EBM; WJM.

Text Book:

Reference Books:
MEC 227 - MANUFACTURING TECHNOLOGY LAB – I
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week : 3 Lab
Examination : 3hrs.

Ses. : 50 Exam : 50
Credits : 2

List of Experiments:
Use of basic tools and operations of the following trades.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Trade</th>
<th>No. of exercises</th>
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<tbody>
<tr>
<td>1.</td>
<td>Foundry</td>
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<tr>
<td>2.</td>
<td>Welding</td>
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<tr>
<td>3.</td>
<td>Lathe Step and taper turning</td>
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<tr>
<td></td>
<td>Thread cutting</td>
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</tr>
<tr>
<td></td>
<td>Offset turning</td>
<td>1</td>
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<tr>
<td>4.</td>
<td>Milling</td>
<td>1 (Spur gear)</td>
</tr>
<tr>
<td>5.</td>
<td>Shaper</td>
<td>1</td>
</tr>
</tbody>
</table>

6. Cylindrical grinding, Surface grinding, Planing, Slotting and Capstan lathe (only demonstration in one class for the entire batch of students).

7. Dissembling and assembling of *
   i. Machine Tool (Lathe)
   ii. I.C. engine
   iii. Pump
   iv. Gear box

* Not for examination.
MEC 228 - ELECTRICAL ENGINEERING LAB  
(Effective from the batch admitted during 2006-2007- Credit System)  
Periods/week : 3 Lab  
Examination : 3hrs.  
Ses. : 50  
Exam : 50  
Credits : 2

List of Experiments:

1. Study and Calibration of wattmeter and energy meter.
3. Verification of KCL and KVL.
4. Superposition theorem.
5. Parameters of a choke coil.
7. Load test on D.C. shunt machine.
8. O.C. test on D.C. separately excited machine.
10. 3 phase induction motor (No load and rotor block tests) load tests.
MEC 229 - Human Values & Professional Ethics  
(Effective from the batch admitted during 2013-2014 - Credit System)  
Total Periods: 30 Th  
Examination (Theory): 3hrs  
Credits : 2  
Pass. Mark: 40  
Ses. : 100  

UNIT_I:  
• Basic Moral Theories:  
  i) Beneficence: doing good to others  
  ii) Non-violence or peace  
  iii) Justice  

UNIT-II:  
• Classification of Ethical Theories:  
  i) Consequentialism-Mill’s utilitarianism-  
     greatest happiness to greatest number of people.  
  ii) Deontology-Kantianism-Actions must satisfy the  
     categorical imperative.  
  iii) Virtue Theory-Aristotelianism virtue is a mean  
     between two extremes of action or passion.  

UNIT-III:  
• Rights & Responsibilities of a citizen:  
  i) Fundamental duties as stipulated in the  
     constitution of India.  
  ii) The rights to individuals guaranteed by Indian  
     constitution.  
  iii) (a) Rights of a professional  
     (b) Professional responsibilities.  

UNIT-IV:  
• Human Values & Attitudes:  
  i) Classification of Values  
  ii) Analysis of desirable values  
  iii) The importance of attitudes in personal &  
     Professional lives.  

UNIT-V:  
• Ethical Living:  
  i) Maslow’s theory of Hierarchy of needs.  
  ii) Clayton Alderfer’s ERG (Existence, Relatedness  
     and Growth) theory.  
  iii) Concept of harmony in life.  

B.E. (MECH.) - III/IV (I SEMESTER)

<table>
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<th>Code</th>
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<th>Periods per week</th>
<th>Max. marks</th>
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<tr>
<td>MEC 311</td>
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<tr>
<td>MEC 312</td>
<td>Mechanics of Solids – II</td>
<td>5</td>
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<td>30</td>
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<td>MEC 313</td>
<td>Engineering Thermodynamics – II</td>
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<td>MEC 314</td>
<td>Theory of Machines – II</td>
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<td>MEC 315</td>
<td>Production Drawing</td>
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<td>MEC 316</td>
<td>Elective-I</td>
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<td>MEC 318</td>
<td>Manufacturing Technology Lab–II</td>
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<td>MEC 319</td>
<td>Soft Skills Lab</td>
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**Total** 25 12 520 380 29

Elective – I:  
(A) Refrigeration and Air Conditioning  
(B) Advanced Foundry and Welding Technology  
(C) Work Study  
(D) Power Plant Engineering  
(E) Finite Element Analysis  
(F) Computer Graphics
MEC 311 – INDUSTRIAL ELECTRONICS  
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th. Ses. : 30 Exam :70
Examination (Theory): 3hrs. Credits : 4

**Devices:** Semi-conductor diode, Zener diode - Transistor - Silicon control rectifier. Rectifiers, Amplifiers, Oscillators, Cathode ray oscilloscope.

**Industrial Applications:** Poly-phase rectifiers - Control circuits - Motor speed control voltage control, Time delay relay circuits - Photo electric circuits. Resistance welding, inducting heating - Dielectric heating.

**Servomechanism:** Open loop and closed loop systems (Elementary treatment only).

**Introduction to Digital Electronics:** Fundamentals of digital electronics, Number system and codes, Logic gates, Boolean algebra, Arithmetic-logic units, Flip-flops, Registers and counters, Memories: ROM, PROM, EPROM and RAM.

**Introduction to Microprocessors:** The Intel-8085 microprocessor; Architecture, Instruction set, Execution of instructions, Addressing structures, Timing and machine cycles of 8085 and programming I/O operations, Interrupts, Serial input and serial output, Programming the I/O ports, Programming the timer.

**Text Books:**
1. Industrial Electronics by Mithal (Khanna Publications).

**References:**
3. Industrial Electronics by Bhatacharya, Tata Mc-Graw Hill.
MEC 312 – MECHANICS OF SOLIDS – II
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th.                   Ses. : 30 Exam :70
Examination (Theory): 3hrs.                  Credits : 4

Fixed Beams: Fixing moments for a fixed beam of uniform and variable sections, Effect of sinking support, slope and deflection.
Continuous beams: Analysis of continuous beam, Reactions at the supports, Effect of sinking of supports.
Energy Methods - Castigliano's theorems I & II applications.
Columns and Struts: Columns with one end free and the other fixed, Both ends fixed, One end fixed and other hinged, Limitation of Euler's formula, Column with initial curvature, Column carrying eccentric load, Laterally loaded columns with Central point load and Uniformly distributed load, Empirical formulae.
Bending of Curved Bars: Stresses in bars of circular, rectangular and trapezoidal sections.
Stresses due to rotation: Wheel rim, disc of uniform thickness, disc of uniform strength.
Thick cylinders subjected to internal and external pressure and compound cylinders.

Text Books:
2. Chapter VI from Advanced Topics in Strength of Materials, by Prof. L.B.Shah and Dr.R.T.Shah.

References:
MEC 313 ENGINEERING THERMODYNAMICS - II
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th.  
Ses: 30 Exam: 70 
Examination (Theory): 3hrs.  
Credits: 4

Properties of Pure Substance: Definition of pure substance, phase change of a pure substance, p-T (Pressure-Temperature) diagram for a pure substance, p-V-T(Pressure-Volume-Temperature) surface, phase change terminology and definitions, property Diagrams in common use, Formation of steam, Important terms relating to steam formation, Thermodynamic properties of steam and steam tables, External work done during evaporation, Internal latent heat, Internal energy of steam, Entropy of water, Entropy of evaporation, Entropy of wet steam, Entropy of superheated steam, Enthalpy-Entropy (h-s) charts for Mollier diagram, Determination of dryness fraction-Tank or bucket calorimeter, throttling calorimeter, separating and throttling calorimeter.


Steam Turbines: Classification of steam turbines- Impulse turbine and reaction turbine- Compounding in turbines- Velocity diagrams in impulse and reaction turbines- Degree of reaction- Condition for maximum efficiency of reaction turbines- Effect of friction on turbines constructional features governing of turbines.

Condensers: Classification of condenser- Jet, Evaporative and surface condensers- Vacuum and its measurement- Vacuum efficiency- Sources of air leakage in condensers- Condenser efficiency- Daltons law of partial pressures- Determination of mass of cooling water- Air pumps.


Text Books:
3. Fundamentals of Engineering Thermodynamics by E. Radhakrishna, PHI.

References:
4. Thermal Science and Engineering by D.S. Kumar, S.K. Kataria and Sons
5. Refrigeration and Air-conditioning, by Ahamadul Ameen, PHI.
MEC 314 - THEORY OF MACHINES - II
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th. Ses: 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

**Gyrovoscopnic Couple and Precesional Motion:** Precessional and angular motion- gyrovoscopic couple-effect of gyrovscopic couple on an aero plane and on a naval ship, stability of a four wheel vehicle moving in a curved path, stability of a two-wheel vehicle taking a turn.

**Cams:** Classification of followers and cams- Definitions- Motions of the follower- Uniform velocity-Simple harmonic motion- Uniform acceleration and retardation- Displacement- Velocity and acceleration diagrams. Construction of cam profiles- Cam with knife edged follower and roller follower- Cams with specified contours- Tangent cam with roller follower- Circular arc cam with flat faced follower.

**Toothed gearing:** Classification of toothed wheels, technical terms, conditions for constant velocity ratio of toothed wheels- Law of gearing- Velocity of sliding of teeth, forms of teeth- Length of contact, arc of contact, interference in involute gears, minimum number of teeth required on pinion to avoid interference- Methods of avoiding interference- Helical gears, Spiral gears- Efficiency of spiral gears.

**Gear Trains:** Types of gear trains- Simple, compound, reverted and epicyclic gear trains- Velocity ratio of epicyclic gear train- Tabular method- Algebraic method- Torques and tooth loads in epicyclic gear trains.

**Balancing of Rotating and Reciprocating Masses:** Balancing of a single rotating mass in the same plane and by two masses in different planes, balancing of several masses revolving in the same plane- Balancing of several masses revolving in different planes- Primary and secondary unbalanced forces of reciprocating masses, Partial balancing of unbalanced primary forces in a reciprocating engine, Partial balancing of locomotives- Effect of partial balancing of reciprocating parts of two cylinder locomotives- Variation of tractive force, Swaying couple and hammer blow- Balancing of primary and secondary forces in multi cylinder in-line engines- Direct and reverse cranks- Balancing of V-Engines.

**Vibrations:** Definitions- Types of vibrations- Natural frequencies of free longitudinal vibrations of systems having single degree of freedom- Equilibrium method- Energy method and Rayleigh's method. Frequency of damped vibration and forced vibration with damping- Magnification factor or dynamic magnifier.

**Transverse and Torsional Vibrations:** Natural frequency of free transverse vibrations due to point load and uniformly distributed load acting over a simply supported shaft- Transverse vibrations for a shaft subjected to number of point loads- Energy method- Dunkerley's method, Critical speed of a shaft. Natural frequency of free torsional vibrations- Free torsional vibrations of single rotor system, two rotor system, three rotor system and gear system.

**Text Book:**

**Reference books:**
3. Theory of Machines by Thomas Bevan.
MEC 315 - PRODUCTION DRAWING

(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 3 Pr.  
Ses: 30  Exam: 70  
Examination (Theory): 3hrs.  
Credits: 2


**Production drawings** of Spur, Bevel and Helical gears, swivel bracket, main spindle, crank, revolving centre, jigs and fixtures.


**Cutting tool layout**. Single point, multi point cutting tools for conventional and CNC machine tools.

**Text Book:**

**References:**
2. Production Technologies, HMT.
MEC 316 - ELECTIVE - I

(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th. Ses: 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

(A) REFRIGERATION AND AIR CONDITIONING

Principles of Refrigeration: Refrigeration and II law of thermodynamics- Methods of Refrigeration- Unit of Refrigeration- Applications of Refrigeration. Air cycle Refrigeration: Reversal Carnot cycle- Bell Colman cycle- Selection of Refrigeration systems for air crafts- Boot strap system- Regenerative cycle- Reduced ambient type- Comparisons of different systems.


Classification of Refrigerants: Nomenclature- Properties- Secondary refrigerants- Selection of refrigerants- Condensers- Air cooled, Water cooled and evaporative type- Evaporators- Once through, flooded, shell and tube Baudelot cooler- Expansion devices- Capillary expansion device, Thermostatic expansion device.

Absorption Refrigeration System: Basic absorption system- Aqua ammonia absorption system- Li-Br absorption refrigeration system- Electrolux refrigeration- C.O.P. of absorption refrigeration system- Comparison of vapour compression and vapour absorption system. Steam jet refrigeration system and analysis- Advantages and limitation- Ejector compression system.

Psychrometry: Psychrometric properties and relations- Psy chart- Psy processes- Human comfort and comfort chart- Effective temperature and factors governing effective temperature. Air conditioning: Summer, Winter and year round air conditioning- Different types of Air conditioning load - By pass factor, RSHP, GSHF- Fresh air quantity- Cooling coils and Dehumidity- Air washers.

Text Books:
1. Refrigeration and Air conditioning, by C.P.Arora.

References:
1. Refrigeration and Air conditioning, by Jordan R.C. and Priester G.B.


Foundry Mechanization: Layout for ferrous and nonferrous foundries- Description of equipment used for mechanization- Sand conditioners- Conveyors- Cranes- Equipment for handling moulds, Cores and molten metal- Knock out of moulds- Fettling equipment.


Text Books:
1. Foundry Technology, by Jain P.L.
2. Welding Engineering and Technology, by R.S. Parmar.

References:
1. Foundry Engineering, by Agarwal.
3. Principles of Metal Castings, by Heine & Others.
(C) WORK STUDY
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th. Ses: 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Introduction to work study: Scientific management – Productivity - Advantages of work study to management, Supervisors and workers.


Principles of Motion Economy: Related to human body, work place, equipment.


Job Evaluation, Techniques of job evaluation - Merit rating - Incentive plans.

Ergonomics: Basics of Ergonomics, Anthropometry.

Text Books:
1. Introduction to Work Study - International Labour Organisation.

References:
1. Motion and Time Study, by Barnes, John Wiley.
(D) **POWER PLANT ENGINEERING**  
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th.  
Ses.: 30  
Exam: 70  
Credits: 4


**Hydro Electric Plants:** Hydrology, Hydrometric survey rainfall, Catchment, Reservoir, Run-off flow and fall, Storage and pondage, Losses due to percolation, Evaporation and transpiration. Mass–duration and flood discharge. Frequency studies and gauging. Different types of plants. Selection of site. Low, medium and high head plants and pumped storage plants. General layout of the plant – Head works, Spillways, Canals, Tunnels, Governing, Lubrication, Penstock, Anchorages and relief valves, different types of surge tanks, intakes, Gates and Valves.

**Nuclear Power Plants:** Classification of reactors, Thermal utilization, Fuels, Fuel moderator and coolant, Control and safety rods, Special properties of structural materials required, Induced radioactivity, Gas cooled reactors, Radiation hazards and shielding, Radio active waste disposal.


**Text Books:**

**References:**
3. Modern Power Plant Engineering by Joel Weisman, Roy Eckart, PHI.
(E) **FINITE ELEMENT ANALYSIS**
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th  
Ses. : 30 Exam: 70  
Examination (Theory): 3hrs.  
Credits: 4


**One-dimensional Problems:** Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach. The Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

**Two-dimensional Problems** Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, Plane strain triangle, In plane and Bending, problem modeling and boundary conditions.

**Axisymmetric Solids Subjected to Axisymmetric Loading:** Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.


**Text Book:**  
1. Introduction to Finite Elements in Engineering, by Tirupathi R. Chandrupatla, Ashok D.Belegundu (chapters 1 to 8 only).

**References:**  
1. Introduction to Finite Element Method, by S.S.Rao  
(F) COMPUTER GRAPHICS
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Geometry and line generation: Line segments, Pixels and frame buffers, Bresenham's algorithms: line, circle, ellipse generation.


Polygons: Polygons representation, An inside test, Filling polygons, Filling with a pattern.

Transformations: Scaling transformations, Reflection and zooming, Rotation, Homogeneous coordinates and translation, Rotation about an arbitrary point.

Segments: The segment table, Segment creation, Closing a segment, Deleting a segment.

Windowing and clipping: The viewing transformation, Clipping, The clipping of polygons, Generalized clipping.

Three dimensions: 3D geometry, 3D primitives, 3D transformations, Parallel projection, Perspective projection, Isometric projections, Viewing parameters, Special projections.


Light, color and shading: Point-source illumination, Shading algorithms, Shadows, Color models.

Curves and fractals: Curve generation, Interpolation, B splines, Curved surface patches, Bezier curves, Fractals, Fractal lines, Fractal surfaces.

References:
MEC 317 - MECHANICAL ENGINEERING LAB-II
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 3 Pr. Ses. : 50 Exam: 50
Examination (Practical): 3hrs. Credits: 2

1. Load test and smoke test on I.C. Engines.
4. Study of multi-cylinder engines and determination of its firing order.
5. Calculations of efficiencies of the given air compressor.
6. Determination of pressure distribution around the given (1) cylinder and (2) airfoil specimens kept in a uniform flow wind-tunnel.
7. Study of automobile mechanisms.
8. Verification of laws of balancing.
9. a) Determination of ratios of angular speeds of shafts connected by Hooke's joint.
   b) Determination of the ratio of times and ram velocities of Withworth quick return motion mechanism.
10. To draw curves of slider displacement and crank angle and linear velocities w.r.t. time for a slider crank mechanism and compare with theoretical values.
11. To determine the relation of gyroscopic couple and compare with the theoretical values.
12. To draw the crank angle vs. pressure diagram for an I.C. engine using pressure transducer and cathode ray oscilloscope.
MEC 318 - MANUFACTURING TECHNOLOGY LAB - II
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 3 Pr. Examination (Practical): 3hrs. 
Ses. : 50 Exam: 50 Credits: 2

1. Experiments on Lathe to establish the following curves
   a) Depth of cut Vs Cutting force.
   b) Feed Vs Cutting force.
   c) Cutting speed Vs Cutting force.
2. Grinding of single point cutting tool as per given specifications (to check the tool angles).
3. Study of chip formations on shaping machine (with lead sample).
4. Torque measurement on drilling/milling machine.
5. Effect of speed and feed on surface roughness.
7. Sieve analysis to evaluate G.F.No.
8. Moisture and clay content test.
10. Shatter Index & Hardness Testing
B.E. (MECH.) - III/IV  
(II-SEMESTER)

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*During summer vacation

Elective – II :  
(A) Gas Turbines and Jet Propulsion  
(B) Automobile Engineering  
(C) Tool Design  
(D) Production Planning and Control  
(E) Robotics  
(F) Mechatronics
MEC 321 - FLUID MECHANICS
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th. Ses : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Properties of fluids: Introduction-Viscosity- Pressure and its measurement , Absolute, Gauge, Atmospheric and Vacuum pressure – Manometers, Simple manometers, Differential manometers. Hydrostatic forces on surfaces- Total Pressure and Pressure Centre- Vertical, Horizontal, inclined and Curved plane surfaces submerged in liquid- Buoyancy and Floatation.


Laminar Boundary Layer: Definition- Laminar Boundary Layer- Turbulent Boundary Layer - Laminar Sub layer- Boundary Layer thickness-Displacement thickness, Momentum thickness and Energy thickness-Momentum integral equation- Flow over a flat plate.

Turbulent Boundary Layer: Laminar- Turbulent transition- Momentum equations and Renold's stresses- Fully developed turbulent flow through a pipe- Turbulent boundary layer on a flat plate- Laminar sub-layer- Boundary layer separation and control.


Compressible Fluid Flow: Thermodynamic relations- Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance- Limits of incompressibility- Pressure field due to a moving source of disturbance- Propagation of pressure waves in a compressible fluids- Stagnation properties- Stagnation pressure, Temperature and density-Area velocity relationship for compressible flow- Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles- Variation of mass flow with pressure ratio-Compressible flow through a venturimeter- Pitot static tube in a compressible flow.

Text Book:

References:
5. Fluid Mechanics by Kothandaraman and Rudramoorthy.
**MEC 322 - DESIGN OF MACHINE ELEMENTS – I**
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th.  
Ses. : 30  
Exam: 70  
Credits: 4

**Introduction to Mechanical engineering design:** traditional design methods, different design models, Problem formulation, Design considerations, engineering materials and processes and their selection, BIS designation of steels, Mechanical properties, Load determination, manufacturing considerations in design.

**Design against static loads:** Modes of failure, Factory of safety, Axial, bending and torsional stresses, Stress concentration factors. Static failure theories.

**Fluctuations and fatigue stresses,** Soderberg, Goodman and modified Goodman diagrams, fatigue failure, design consideration in fatigue.

**Threaded and welded joints:** forms of threads, basic types of screw fastenings, ISO metric screw threads, eccentrically loaded bolted joints, Torque requirement for bolt tightening, Fluctuations loads on bolted joints, fasteners, Joints with combined stresses. Power screws, Force analysis. Collar friction, Differential and compound screws design. Types and strength of weld joints subjected to bending and fluctuating loads, cotter and knuckle joints, welded joints, different types welded joints and their design aspects, welding inspection.

**Shafts, keys and couplings:** shafts design on strength basis, torsional rigidity basis, Design of hollow shafts, flexible shafts, ASME codes for shafts, Keys and cotter design, Flat, square keys, Splines, Rigid and flange couplings, Flexible couplings.

**Spring Design:** classification and spring materials, Spring end formation, Design of helical compression springs, helical extension springs, torsion springs, laminated springs, Protective coatings, Equalized stress in spring leaves. Multi - leaf springs. Surge in springs, Nipping and shot peening.

**Text Books:**
1. Design of Machine Elements by V.B.Bhandari, TMH Publishing Co. Ltd., New Delhi

**References:**
2. Machine Design by Pandya and Shaw, Charotar publications
MEC 323 - MANUFACTURING TECHNOLOGY – III
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th Sess.: 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Automatic screw lathes, Multi spindle automatic lathes, Turret lathes, Numerical control, NC operation, Coordinate system, Data input devices, Data storage, Programme editing, Machining centres, Turning centres, Vertical turning centres, Milling centres, Advantages of NC, Computers & NC, CNC, DNC, CAD/CAM, Computer graphics, Computer aided manufacturing, Robots, Flexibility in manufacture, Automatic sensing for FMS, Areas affected by FMS, Steps toward automatic factory.

CNC part programming: Designation of co-ordinate axes for CNC machines, Functions of machine control units, Tape format, Manual part programming and computer assisted part programming (using APT language). Exercises involving simple contours and positioning.

ISO system of limits, Fits and Tolerances, Interchangeability, Plain limit gauges, Measurement of screw threads, major diameters, Minor diameters and effective diameter, Pitch, Limit gauges for internal and external threads, Measurement of spur gears, pitch, profile, lead, backlash, tooth thickness.

Tool maker's microscope, Straightness measurement, Slip gauges, Twisted strip mechanical comparator, Optical lever comparator, Optical projector, Electric comparator, Pneumatic comparator, Squareness testing, Optical bevel protractor, Sine bar, Angle gauges, Precision level, Autocollimator, Angle dekkor, Optical dividing heads and rotary tables, Flatness measurement, Roundness measurement. Co-ordinate measuring machines.


Text Books:

References:
MEC 324 - INDUSTRIAL ENGINEERING AND MANAGEMENT
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th
Exam: 70
Ses. : 30
Credits: 4

Examination (Theory): 3hrs.


Introduction to personnel management- Functions, Motivation, Theories of motivation, Hawthorne studies, Discipline in industry, Promotion, Transfer, lay off and discharge, Labour turnover.


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

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

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

Plant Maintenance: Objectives and types.


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).

Quality Control - Control charts of variables and attributes (Use of formulae only). Single and Double sampling plans.

Text Book:
1. Industrial Engineering Management, by Dr. O. P. Khanna.

References:
2. Production and Operations Management by Everette Adam & Ronald Ebert.
4. Industrial Engineering and Production Management by Telsay, S. Chand & Co.
MEC 326 - ELECTIVE – II
(A) GAS TURBINES AND JET PROPULSIONS
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5Th  Ses.: 30 Exam: 70
Examination (Theory): 3hrs.  Credits: 4


Text Books:

Reference Books:
(B) AUTOMOBILE ENGINEERING
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5Th	Ses.: 30 Exam: 70
Examination (Theory): 3hrs.
Credits: 4


**Clutch:** Necessity, Clutch Assembly: Construction and Working Principle, Types: Single and Multiple Plates, Free-Play, Fluid coupling/Torque converter, Clutch Troubles and Remedies.


**Text Books:**

**Reference Books:**
(C) TOOL DESIGN
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5Th
Examination (Theory): 3hrs.


Jigs & Fixtures: Drill bushes-Different types of Jigs-Plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs- Automatic drill jigs-Rack & Pinion Operated, Air operated Jigs Components.
General principles of lathe, milling and broaching fixtures-Grinding, Drilling and shaping fixtures, Assembly, Inspection and Welding fixtures-Modular fixtures. Design and development of Jigs and fixtures for simple components.

Press Tools: Press working terminology-Presses and Press accessories-Computation of capacities and tonnage requirements-Design and development of various types of cutting, forming and drawing dies.


Design of Limit Gauges: Elements, types and application of limit gauges, Gauge materials, their selection, Taylor’s principles of gauge design, Types and methods to provide gauge tolerances. Design steps and design of plug & ring / snap gauge for given dimension and application.

Text Books:

References:
(D) PRODUCTION PLANNING AND CONTROL
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5Th
Examination (Theory): 3hrs.

Ses: 30 Exam: 70
Credits: 4

Production Planning and Control: Introduction-Definition-Functions of PPC- Objectives-
Terminology- Types of Production-Production Control Department in Relation to Types of
Production.

Forecasting: Introduction- Statistical forecasting techniques- Moving average-Exponential smoothing
technique-Errors in forecasting and evaluation of forecasting techniques.

Process Planning, Computer aided Process Planning: production Control Procedures-Order, Flow ,
Load and Block types of Control-Production control Organization-Place and Significance of
Production control Department in an Industry.

Inventory Management: Introduction-Definition - Types of Inventory - EOQ and EBQ Models with
and without shortages - Buffer stock, Re-order Level- Inventory control techniques - Make or buy
decision - Material requirement planning- MRP-II- JIT.

Planning: Engineering aspects-Aggregate Planning- Master Processing instructions- Identification
Systems- Production inventory programs- work design and job design-
Routing-Steps in routing- Rout sheet.

Scheduling: Forward and Backward Scheduling- Master Scheduling- Evaluation of Job Shop
Schedules with reference to Priority Scheduling rules, Sequencing, Assignment techniques in
Production Scheduling.

Dispatching and Expediting: Centralized and Decentralized Dispatching- Functions in Dispatching-
Dispatching policies- Progress reports- Gantt Load Charts and Schedule Charts- Use of components
for production control other information processing systems- Computers in PPC

Text Books:
2. Donald Denmar - Management of Industrial Organization.
3. Moor and Deblonke - Production Control
5. Everette.Adam, Jr. and Ronald J. Ebert- Production and Operation Management

References:
1. Production Planning and Inventory Control, Narasimhan, Mc Leavy, Billington, PHI(1999)
2. Operation Management- Strategy and Analysis, Lee Krajewski and Larry P. Ritzman, Addison-
Wesley (2000).
5. Manufacturing Planning and Control Systems by Vollmann, Thomas, E. and Others, Richard D.
ROBOTICS
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5Th Exam: 70
Examination (Theory): 3hrs. Ses: 30 Credits: 4

Introduction: Background- Historical Development-Robot Arm kinematics and Dynamics-Manipulator Trajectory Planning and Motion Control-Robot Sensing- Robot Programming Language-Machine Intelligence.

Robot Arm kinematics: Introduction – The Direct Kinematics Problem-The Inverse Kinematics Solution.


Planning of Manipulator Trajectories: Introduction-General Considerations on Trajectory Planning- Joint Interpolated Trajectories- Planning of Manipulator Cartesian Path Trajectories.


Robot Programming Languages: Introduction- Characteristics of Robot Level Languages-Characteristics of Task Level Languages.

Text Book:

Reference Books:
2. Robot Analysis- The Mechanics of Serial and Parallel Manipulators By Lung-Wen Tsai, Jhon Wiley and Sons,Inc
**MECHATRONICS**
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5Th Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

**Mechatronics system design:** Introduction to Mechatronics: What is mechatronics, Integrated design issues in mechatronics, Mechatronics key elements, The mechatronics design process, Advanced approaches in mechatronics.

**Modelling and simulation of physical systems:** Simulation and block diagrams, Analogies and impedance diagrams, Electrical systems, Mechanical translational systems, Mechanical rotational systems, Electromechanical coupling, Fluid systems.


**Signals, systems and controls:** Introduction to signals, systems and controls, System representation, Linearization of nonlinear systems, Time delays.

**Real time interfacing:** Introduction, Elements of a data acquisition and control system, Overview of the I/O process, Installation of the I/O card and software.

**Advanced applications in mechatronics:** Sensors for condition monitoring, Mechatronic control in automated manufacturing, Artificial intelligence in mechatronics, Microsensors in mechatronics.

**Text Book:**

**References:**
MEC 326 - ENGINEERING THERMODYNAMICS-III
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5Th
Examination (Theory): 3hrs.

Exams: 70
Credits: 4


Combustion in I.C. Engines: S.I. engines- Normal combustion and abnormal combustion-Importance of flame speed and effect of engine variables-types of abnormal combustion pre-ignition and knock. Fuel requirements and fuel rating, anti-knock additions- Combustion chamber requirements and Types of combustion chamber- Design principles of combustion chambers-C.I. engines- Stages of combustion- Delay period and its importance- effect of engine variables, diesel knock, suction compression and combustion induced turbulence, open and divided combustion chambers.

Reciprocating and Rotary Compressors: Reciprocating compressors-effect of clearance in compressors, volumetric efficiency-single stage and multi stage compressors-effect of inter cooling in multi stage compressors-Vane type blower-centrifugal compressor- Adiabatic efficiency- Diffuser-Axial flow compressors- Velocity diagrams, degree of reaction, performance characteristics.

Gas Turbines: Simple gas turbine plant- Ideal cycle, closed cycle and open cycle for gas turbines-Efficiency, work ratio and optimum pressure ratio for simple gas turbine cycle- Parameters of performance- Actual cycle, regeneration, Inter-cooling and reheating, closed and semi-closed cycle-Jet propulsion and Rockets.

Nuclear power plants: Classification of reactors-Thermal utilization-Fuels, Fuel moderator and coolant, Control and safety rods, Special properties of structural materials required, Induced radioactivity-Gas cooled reactors, Radiation hazards and shielding-Radio active waste disposal.


Text Books:

References:
2. I.C. Engines, by Mathur and Nehata.
5. I.C. Engines by V. Ganesan.
6. Power Plant Engineering, P.K.Nag
7. Non Conventional Energy Sources, G.D.Rai
MEC 327 - METROLOGY LAB./MECHATRONICS LAB.
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week : 3 Pr.                                                                                         Sess. : 50    Exam : 50
Examination (Practical): 3hrs.                                                                                          Credits: 2

METROLOGY LAB. EXPERIMENTS - (Any Five)
1. Calibration of the following instruments: (using slip gauges)
2. Measurement of taper angle using
3. Alignment tests:
   i. Parallelism of the spindle  ii. Circularity & Concentricity of the spindle
   iii. Trueness of running of the spindle.
4. Gear parameters Measurement
   i. diameter, pitch/module ii. Pitch circle diameter iii. Pressure angle  iv. Tooth thickness.
5. Check the flatness of a surface plate.
   i. Using spirit level  ii. Using Auto-collimator
6. Using light wave interference:
   i. Study of flatness of slip gauges  ii. To find the height of a slip gauge.
7. Tool Maker's Microscope:
   i. Establish the thread details  ii. To find the cutting tool angles.
8. Miscellaneous:
   i. To find the diameter of a cylindrical piece  ii. Taper angle of a V-block
   iii. Central distance of two holes of a specimen.

MECHATRONICS LAB. EXPERIMENTS - (Any Five)
I. Training on Programmable Logic Controller (any ONE of the Following)
   i) Lift Control Using Ladder Logic Programme
   ii) Traffic Signal Control using Ladder Logic Programme
II. Training on Programmable Logic Controller - Sensor Training Kit
    a) Proximity Switch
    b) Photo Electric Switch
    c) Limit Switch
III. Training on Sensor and Transducer (any ONE of the Following)
    i). Linear position or Force applications
       a. LVDT (Linear variable differential transformer)
       b. The strain gauge Transducer
    ii). Rotational Speed or Position Measurement (The inductive Transducer)
    iii). Linear or Rotational Motion
       a. D.C. Solenoid
       b. D.C. Relay
IV. Training on Automation Studios
    i). Punch Machine operation
    ii). Hydraulic Cylinder operation
V. Training on Material Handling
VI. Training on any Controller Package
VII. Training on Servo Fundamental Trainer.
MEC 328 - INDUSTRIAL ENGINEERING LAB
(Effective from the batch admitted during 2006-2007- Credit System)
Periods/week : 3 Pr. Ses. : 50 Exam : 50
Examination (Practical): 3hrs. Credits: 2

List of Experiments:
1. To measure the skill and dexterity in the movement of Wrist and Fingers using pin board.
2. To measure the Heart beat using Stethoscope.
3. To show that the sample means from a normal universe follow a normal distribution.
4. To draw the control chart for fraction defective for a given lot of marble balls.
5. To determine the cycle time using PMTS.
6. To draw two handed process charts for
   i. Bolt, Washer and nut assembly
   ii. Assembly of electric tester.
7. To study the changes in heart rate for different subjects using Tread mill.
8. To draw Multiple Activity chart using an electric toaster.
9. To determine the percentage utilization using work sampling.
10. To study the process capability of a given process.
11. To measure the Heart rate during working and recovery periods of the subjects under different loads, using Bicycle ergometer.
12. To draw flow process charts on activities in Workshop/ Laboratory/Office.
13. To determine the time required to perform motion sequence using work factor system.
14. To draw SIMO charts for
   i. Ball point pen assembly
   ii. Electric plug assembly.
15. To conduct time study of the bulb holder assembly operation of the existing method.
16. To collect the anthropometrics data using 'Anthropolometer'.
MEC 319 – SOFT SKILLS LAB.
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week : 3 Pr  
Credits: 1

(Common for all Branches of Engineering)

Communication:
Importance of communication
Non verbal communication
Personal appearance
Posture
Gestures
Facial expressions
Eye contact
Space distancing

Goal setting:
Immediate, short term, long term,
Smart goals, strategies to achieve goals

Time management:
Types of time
Identifying time wasters
Time management skills

Leadership and team management:
Qualities of a good leader
Leadership styles
Decision making
Problem solving
Negotiation skills

Group discussions:
Purpose (Intellectual ability, creativity, approach to a problem, solving, tolerance, qualities of a leader)
Group behavior, Analyzing performance

Job interviews:
Identifying job openings
Preparing resumes & CV
Covering letter
Interview (Opening, body-answer Q, close-ask Q),
Types of questions

Reference books:

1. ‘Effective Technical Communications’ by Rizvi M. Ashraf, McGraw–Hill Publication
2. ‘Developing Communication Skills’ by Mohan Krishna & Meera Banerji, Macmillan
3. ‘Creative English for Communication’ by N.Krishnaswami & T.Sriraman, Macmillan
### IV YEAR
#### FIRST SEMESTER

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<tr>
<td>MEC 412</td>
<td>Heat and Mass Transfer</td>
<td>5</td>
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<td>MEC 413</td>
<td>Fluid Machinery and Systems</td>
<td>5</td>
<td>70</td>
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<tr>
<td>MEC 414</td>
<td>Statistical Quality Control</td>
<td>5</td>
<td>70</td>
<td>30</td>
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<tr>
<td>MEC 415</td>
<td>Elective – III</td>
<td>5</td>
<td>70</td>
<td>30</td>
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<tr>
<td>MEC 416</td>
<td>Operation Research</td>
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<td><strong>Total</strong></td>
<td></td>
<td>30</td>
<td>6</td>
<td>520</td>
</tr>
</tbody>
</table>

Elective – III:
- (A) Computational Fluid Dynamics
- (B) Non-Conventional Energy Sources
- (C) Computer Numerical Control and Computer Aided Manufacturing
- (D) Total Quality Management
- (E) Optimization Design
- (F) Engineering Tribology
MEC 411 – DESIGN OF MACHINE ELEMENTS - II  
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Ses.: 30 Exam:70
Examination (Theory): 3hrs. Credits: 4


Text books:

References:
MEC 412 – HEAT AND MASS TRANSFER
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th.  
Ses. : 30 Exam: 70  
Examination (Theory): 3hrs  
Credits: 4

Introduction: Basic modes of heat transfer- Rate equations- Generalized heat conduction equation in Cartesian, Cylindrical and Spherical coordinate systems.

Steady state heat conduction solution for plain and composite slabs, cylinders and spheres-Critical thickness of insulation- Heat conduction through fins of uniform and variable cross section- Fin effectiveness and efficiency.

Unsteady steady state heat conduction- Transient heat conduction- Lumped system analysis, and use of Heisler charts.

Convection: Continuity, momentum and energy equations- Dimensional analysis- Boundary layer theory concepts- Free, and Forced convection- Approximate solution of the boundary layer equations- Laminar and turbulent heat transfer correlation- Momentum equation and velocity profiles in turbulent boundary layers- Application of dimensional analysis to free and forced convection problems- Empirical correlation.


Boiling: Different regimes of boiling- Nucleate, Transition and Film boiling.

Condensation: Laminar film condensation- Nusselt's theory- Condensation on vertical flat plate and horizontal tubes- Dropwise condensation.


Text Books:

References:
3. Heat and mass transfer by Kothandaramanna, New Age International.
MEC 413 – FLUID MACHINERY AND SYSTEMS
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Ses.: 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Impact of jet and jet propulsion: Impact of jet on stationary surfaces- Impact of jet on hinged surfaces- A moving curved vane high tangential entry of water- Radial flow over the vanes-Jet propulsion.


Specific Speed: Determination- Significance- Unit quantities- Unit speed- Unit discharge and unit power- Characteristic curves of hydraulic turbines- Constant heat curves- Constant speed curves and Iso-efficiency curves- Governing of turbines.

Centrifugal Pumps: Main parts- Efficiency- Minimum speed for starting- Multi-stage centrifugal pumps- Specific speed of a centrifugal pump- Priming of a centrifugal pump- Characteristic curves- Main, Operational and constant efficiency curves- Cavitation- Effects- Cavitation in Hydraulic machines.

Reciprocating Pumps: Main parts- Classification- Velocity and acceleration variation in suction and delivery pipes due to piston acceleration- Effect of variation of velocity on friction in suction and delivery pipes- Effect of acceleration in suction and delivery pipes on indicator diagram- Effect of friction- Maximum speed of reciprocating pump- Air vessels.


Text Book:

Reference:
MEC 414 – STATISTICAL QUALITY CONTROL
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Introduction to quality, definitions, Taguchi’s loss function, examples of off-line and on-line quality control techniques, quality costs, Deming’s philosophy, introduction to six sigma concept.

Shewart’s normal bowl, control charts for variables, $\bar{X}$, $R$ and sigma control charts, theory of runs, ARL and ATS, Type-I and Type-II errors

Control charts for attributes, $p$-chart, standardized $p$–chart, $np$-chart, $c$-chart, $u$-chart, demerit control chart.

Process capability analysis: using frequency distribution and control charts. Process capability ratios, $C_p$ and $C_{pk}$ Process capability ratios for nominal the batter type, smaller the better type and larger the better type product specifications.

Sampling plans: single, double, multiple and sequential sampling plans, rectifying inspection, $AOQ$, $AOQL$, and $ATI$. Use of Dodge Romig Tables, Design of single and sequential sampling plans.

Text Books:
1. Introduction to statistical quality control by E.L. Grant
2. Introduction to statistical quality control by D.C. Montgomery
MEC 415 - ELECTIVE - III
MEC 415(B) – NON CONVENTIONAL ENERGY SOURCES
(Effective from the batch admitted during 2006-2007- Credit System)

Periods/week: 5 Th.  Ses. : 30  Exam: 70
Examination (Theory): 3hrs.  Credits : 4

Principles of solar radiation: Role and potential of new and renewable source, the solar energy option, environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

Solar energy collectors and their applications: Flat plate collectors, concentric collectors, classification, orientation, thermal analysis and concentrated collectors.

Solar energy storage: Different methods, sensible heat, latent heat, stratified storage, solar ponds.

Solar Applications: Solar heating and cooling, techniques of solar distillation and drying, photovoltaic energy conversion.

Wind energy: Sources and potential vertical axis windmills, performance characteristics, Betz limit.


Geothermal energy: Resources, types of wells, methods of harnessing the energy, potential in India.

Ocean energy: Ocean thermal energy conversion (OTEC), principles of utilization, setting up of plants, thermodynamic cycles.

Tidal and Wave energy: Potential and conversion techniques, mini hydel power plants and their economies.

Direct energy conversion: Need for direct energy conversion, Carnot’s cycle, limitations, principles of DEC, thermoelectric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications.

Magneto Hydrodynamic Generators (MHD): Principles, dissociation and ionization, Hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems.

Fuel cells: Faraday’s laws, thermodynamic aspects, selection of fuels, operating conditions.

TEXT BOOKS:
1. Non-Conventional Energy Sources by G.D. Rai
2. Renewable Energy Resources by Tiwari and Ghosal, Narosa Publications.

REFERENCES:
1. Renewable Energy Sources by Twidell & Weir
2. Solar Energy by Sukhatme
7. Renewable Energy Technologies by Ramesh and Kumar, Narosa Publications.
MEC 415 - ELECTIVE - III
MEC 415(C) – Computer Numerical Control and Computer Aided Manufacturing
(Effective from the batch admitted during 2006-2007 Credit System)

Periods/week: 5 Th.  
Ses.: 30 Exam: 70
Examination (Theory): 3hrs.  
Credits: 4

Introduction to CNC and CAM, CNC retrofitting, Adoptive control machining, NC part program preparation through computer languages. Group technology: Merits & demerits, Organisation, Classification and Coding systems, Facilities layout.
Computer aided process planning: Introduction to process planning, Methods of process planning, Computer aided process planning, CAPP systems, case studies.
Computer aided material handling and production planning: Robots: Structure and operation of Robots, robot sensors and applications. Automatic conveyor systems. Automated guided vehicles. Aid of computer in production planning and control, Inventory control and material requirement planning.
FMS & CIMS: Building blocks of Flexible Manufacturing Systems (FMS), Machining systems of FMS, Tool management systems, Advantages of FMS, Computer integrated manufacturing systems (CIMS).

Text Books:

Reference:
MEC 415 - ELECTIVE - III
MEC 415(D) – TOTAL QUALITY MANAGEMENT
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Ses. : 30 Exam :70
Examination (Theory): 3hrs. Credits : 4

Concepts of TQM: Philosophy of TQM, Customer focus, Organization, Top management commitment, Team work, Quality philosophies of Deming, Crossby and Muller.

TQM process: QC tools, Problem solving methodologies, New management tools, Work habits, Quality circles, Benchmarking, Strategic quality planning.

TQM systems: Quality policy deployment, Quality function deployment, Standardization, Designing for quality, Manufacturing for quality.

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

Implementation of TQM: Steps, KAIZEN, 5S, JIT, POKAYOKE, Taguchi methods, Case studies.

References:
MEC 415 - ELECTIVE - III
MEC 415(E) – OPTIMIZATION DESIGN
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Ses. : 30 Exam :70
Examination (Theory): 3hrs. Credits : 4

Introduction to Optimization: Engineering applications of optimization- Statement of an optimization problem- Classification of optimization problem- Optimization techniques.


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


Text Book:

References:
MEC 415 - ELECTIVE - III
MEC 415(F) – ENGINEERING TRIBOLOGY

(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Exam : 70
Ses. : 30 Credit : 4

Examination (Theory): 3hrs.

Introduction: history, industrial significance, different types of bearings,
Properties and testing of lubricants: viscosity, viscometry, effect of temperature and pressure
on viscosity, physical properties of mineral oils, generalized Reynolds’s equation
Engineering surfaces – properties and measurements: different measuring methods, statistical
description, fractal description
Surface contact: Non –confirming Surface contact geometry, stresses in Non –confirming
Surface, contact of surface roughness, numerical surface contact models
Adhesion, Friction, Wear: adhesion models, factors influencing adhesion, stiction, various
types of frictions, laws of wear, types of wear, minor forms of wear, methods for reduction of
wear and friction and ferrography, surface engineering
Boundary lubrication: Liquid lubrication, fluid film lubrication, liquid and solid lubricants,
properties of lubricants, typical lubricant tests, additives, Fluid film lubrication
Bearings: hydrodynamic thrust bearings, hydrodynamic journal bearings, hydrodynamic
squeeze film bearings, hydrostatic bearings, gas lubricated bearings and rolling element
bearings and antifriction bearing, Nano tribology

Text books:
1. Introduction to tribology of bearings, B.C. Majumdar, a.h. wheelers and co
2. Engineering tribology, Prasanta Sahu, Prentice - Hall of India, 2005
   of India, 2005
MEC 417 - HEAT AND MASS TRANSFER LAB
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 3 Pr. Ses.: 50 Exam: 50
Examination (Practical): 3hrs. Credits: 2

List of Experiments:
1. Study of conduction phenomena in the composite slab system.
2. Determination of emissivity, time constant, Fourier's Biot module and study of variation of temperature with respect to time on a circular disc.
3. Study of heat transfer by forced convection through a horizontal test section.
4. Study of heat transfer by forced convection through a vertical test section.
5. Determination of free convective heat transfer coefficient from a horizontal cylinder in air.
6. Determination of thermal conductivity of brass employing it as a fin.
7. Tests on natural convection and pool boiling.
8. Study of forced convection with turbulence promoters.
9. Study of condensation on fin.
10. Tests on film condensation.
11. Determination of COP of a vapour compression refrigeration system.
12. Study of vapour compression air conditioning system.
MEC 418 – FLUID MECHANICS AND MACHINERY LAB
(Effective from the batch admitted during 2006-2007 Credit System)

Periods/week : 3 Pr.
Examination (Practical): 3hrs.

Ses. : 50 Exam : 50
Credits: 2

List of Experiments:
1. Calibration of flow meters,
   a. Venturi meter
   b. Orifice meter
   c. Nozzle meter
2. Determination of coefficient of discharge for
   a. small orifice
   b. cylindrical mouth piece
3. Finding coefficient of discharge for
   a. rectangular notch
   b. triangular notch
   c. trapezoidal notch
4. To draw the performance characteristics of C.F. pump.
5. To find the specific speed of
   a. Pelton turbine
   b. Francis turbine
6. To draw the characteristic curves for reciprocating pump.
7. To draw the pressure distribution and finding coefficient of drag for
   a. a bluff body
   b. an Aero foil
8. To draw the characteristic curves for the hydraulic ram.
<table>
<thead>
<tr>
<th>Code</th>
<th>Name of the subject</th>
<th>Periods per week</th>
<th>Max. marks</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>MEC 421</td>
<td>Instrumentation and Control Systems</td>
<td>5</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>MEC 422</td>
<td>Computer Aided Design</td>
<td>5</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>MEC 423</td>
<td>Engineering Economics</td>
<td>5</td>
<td>70</td>
<td>30</td>
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<tr>
<td>MEC 424</td>
<td>Project</td>
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<td>50</td>
</tr>
<tr>
<td>MEC 425</td>
<td>Computer Aided Design Lab</td>
<td>3</td>
<td>50</td>
<td>50</td>
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<td><strong>Total</strong></td>
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<td>15</td>
<td>9</td>
<td>310</td>
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MEC 421 – INSTRUMENTATION AND CONTROL SYSTEMS
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Ses. : 30 Exam :70
Examination (Theory): 3hrs. Credits : 4

Instrumentations: Concepts of measurements, static performance, characteristics accuracy of measurement and its analysis. Instrumentation, for measurement: Force, torque, strain, pressure, flow, temperature and vibration.

Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement.

Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.


Text Books:
1. Automatic Control Systems, by Benjamin C. Kuo.

References:
MEC 422 – COMPUTER AIDED DESIGN
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th. Examination (Theory): 3hrs.
Ses. : 30 Exam :70 Credits : 4

Fundamentals of CAD - Introduction - The design process - Application of computers for
   design - Operating systems - Hardware in CAD: The design work station - I/O Devices -
   CAD system configuration - Creating database for manufacturing - Benefits of CAD.

Interactive Computer Graphics - Graphic display devices - Graphics system - Graphics
   standards - Graphical user interface - Transformation systems - windowing - clipping - 2D and
   3D transformations - Linear transformation- Display files for 3D data - Geometric Modeling -

Introduction to Finite Element Analysis - CAD techniques to finite element data preparation-
   Automatic mesh generation- presentation of results - 3-dimensional shape description and
   mesh generation- CAD applications of FEM.

CAD applications and exposure to CAD packages: Simple examples of computer aided
drafting, design and analysis - Introduction to simple machine elements - Analysis of cross
sectional area, centroid & moment of inertia- Kinematics of crank- slider mechanism and
other simple design applications. Introduction to CAD packages like ANSYS, NASTRON,
NISA-II.

Introduction to Artificial Intelligence Introduction to Artificial Intelligence - Applications of
AI in design and CAD.

Text Books:
1. CAD/CAM- Computer Aided Design & Manufacturing, by M.D.Groover &
   E.W.Zimmer.

References:
6. CAD/CAM/CIM by Radhakrishna, New age international.
MEC 423 – ENGINEERING ECONOMICS
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 5 Th.  Ses. : 30 Exam : 70
Examination (Theory): 3hrs.  Credits : 4

Utility, value, wealth, consumption, wants, necessaries, comforts and luxuries. laws of demand, elasticity of demand.
Production, agents of production, laws of returns. Forms of business organization. Single trader, partnership and public limited company.
Price determination in perfect competition, monopoly and imperfect competition. Rent, interest, money, cheques, bills of exchange.
Costing- Cost concepts, Elements of cost, Methods of distribution of overhead costs. Unit costing, Job costing and process costing.
Break- Even analysis, Depreciation methods, Preparation of profit and loss account and balance sheet (Outlines only).

Text Book:

References:
MEC 424 - PROJECT
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week : 6 Pr.  
Ses. : 50 Exam : 50
Credits: 8

Project topic to be decided by the guide/department.
MEC 425 - COMPUTER AIDED DESIGN LAB
(Effective from the batch admitted during 2006-2007 - Credit System)

Periods/week: 3 Pr.                                      Ses: 50                                      Exam: 50
Examination (Practical): 3hrs.                       Credits: 2

CAD experiments:
1. Initiating the graphics package; Setting the paper size, space; setting the limits, units; use of snap and grid commands.
2. Drawing of primitives (line, arc, circle, ellipse, triangle etc.)
3. Drawing a flange.
4. Drawing a Bushing assembly.
5. Dimensioning the drawing and adding text.
6. Setting the layers and application of the layers.
7. Isometric and orthographic projections.
8. Viewing in Three dimensions.

CAM experiments:
1. Preparation of manual part programming for CNC turning/Milling.
2. Part programming preparation through AutoCAD.
3. APT part programming for 2D - contour.
4. Machining of one job on CNC machine tool.
5. Robot programming through Teaching Box method.
6. Robot programming through computer.
MODEL QUESTION PAPER

B.E. IV/IV MECHANICAL – I SEMESTER
(Common to Mechanical and MPIE)

OPERATIONS RESEARCH

Time : 3 Hrs. 

Max. Marks : 70

Answer question No. 1 and

Answer any FOUR questions from remaining.

Assume suitable missing data wherever necessary.

Answers to question No.1 must be at one place.

All questions carry marks.

1. a) State the condition for cycling to occur in simplex method.
   b) What is a traveling salesman problem?
   c) State the conditions required for processing of n jobs on m machines.
   d) What is independent breakdown replacement?
   e) State the major difference between pure strategy and mixed strategy in game theory.
   f) How do you evaluate standard deviation for a networks.
   g) What are uncontrolled variables in inventory problems?

2. a) Define and explain optimum solution and feasible solution of a L.P.P.
   b) Use simplex method to

   \[
   \text{Maximize } \quad z = 7x_1 + 5x_2 \\
   \text{Subject to } \quad x_1 + 2x_2 \leq 6 \\
   \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad 4x_1 + 3x_2 \leq 12 \\
   \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad x_1, x_2 \geq 0
   \]

3. a) For the following transportation problem, obtain a basic feasible solution by Vogel’s approximation:

<table>
<thead>
<tr>
<th>DESTINATION</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>40</td>
<td>20</td>
<td>210</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>80</td>
<td>35</td>
<td>160</td>
<td>6</td>
</tr>
<tr>
<td>III</td>
<td>240</td>
<td>190</td>
<td>40</td>
<td>8</td>
</tr>
</tbody>
</table>

   Demand: 8 4 4

   b) What is an assignment problem? Explain the ‘Hungarian’ method of solving it.

4. Find the sequence that minimizes that total elapsed time required to complete the following tasks. Each job is processed in the order A C B:

<table>
<thead>
<tr>
<th>Jobs</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>5</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Time on B</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>4</td>
<td>7</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Machine C</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

5. Compute the economic lot size, the associated total cost and the length of time between two orders, given that the set up cost is Rs.100/-, the daily holding cost per unit of inventory is 5 paise and the daily demand is 30 units. Derive the formulae used.

6. A special purpose machine costs Rs. 1 lakh, annual operation and maintenance cost is Rs.1,000/- and increases at a rate of Rs.750/- for 2\textsuperscript{nd} and 3\textsuperscript{rd} year and at a rate of Rs.1250/- for the remaining life. The life of equipment is 10 years. Salvage value at the end of first year is Rs.80,000/- and falls at a rate of Rs.10,000/- every year for the first 4 years. After words it has no salvage value. What should be economic life of lathe if the rate of return on capital invested is 25%?

7. a) Explain how a 2-person zero-sum game can be solved by linear programming.
b) Determine the optimum strategies for the following 4 × 4 game:

\[
\begin{array}{cccc}
& I & II & III & IV \\
I & 4 & 1 & 8 & 5 \\
II & 2 & 8 & 2 & 6 \\
III & –2 & 0 & 4 & 2 \\
IV & 1 & 7 & 3 & 3 \\
\end{array}
\]

8. Consider a project for which the following activities and the time estimates have been obtained:

<table>
<thead>
<tr>
<th>Activity (a, b, m)</th>
<th>Activity (a, b, m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2 (5, 8, 6)</td>
<td>3, 6 (3, 5, 4)</td>
</tr>
<tr>
<td>1, 4 (1, 4, 3)</td>
<td>4, 6 (4, 10, 8)</td>
</tr>
<tr>
<td>1, 5 (2, 5, 4)</td>
<td>4, 7 (5, 8, 6)</td>
</tr>
<tr>
<td>2, 3 (4, 6, 5)</td>
<td>5, 6 (9, 15, 10)</td>
</tr>
<tr>
<td>2, 5 (7, 10, 8)</td>
<td>5, 7 (4, 8, 6)</td>
</tr>
<tr>
<td>2, 6 (8, 13, 9)</td>
<td>6, 7 (3, 5, 4)</td>
</tr>
<tr>
<td>3, 4 (5, 10, 9)</td>
<td></td>
</tr>
</tbody>
</table>

Draw the network to determine the probability of the project getting completed as per schedule.

**MODEL QUESTION PAPER**

B.E. IV/IV MECHANICAL ENGINEERING – II SEMESTER
(Mechanical only)

MCH-424 Elective – II: OPTIMIZATION OF DESIGN

Time: 3 Hrs.  Max. Marks: 70

Answer question No. 1 and any FOUR questions from the remaining.

Assume suitable missing data wherever necessary.

Answers to question No. 1 must be at one place.

All questions carry equal marks.

1. Answer all the following: (7 × 2 = 14)
   a) State five engineering applications of optimization.
   b) Define a saddle point and indicate its significance.
   c) What is an interval of uncertainty and what is a pivot operation?
   d) Why is refitting necessary in interpolation methods?
   e) What is the difference between the interior and extended interior penalty function?
   f) What is normality condition in a geometric programming problem?
   g) Give two engineering examples of a discrete programming problem.

2. a) Consider the following optimization problem
   
   Maximize \( f = -x_1 - x_2 \)
   Subject to \( x_1^2 + x_2 \geq 2 \),
   \( 4 \leq x_1 + 3x_2 \),
   \( x_1 + x_2^2 \leq 30 \)
   
   Find whether the design vector \( X = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \) satisfies the Kuhn-Tucker conditions for a constrained optimum.

   b) What are the values of the Lagrange multipliers at the given design vector?

3. Minimize the function:
   \( f = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2 \)
starting from the point $X_1 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ along the direction $S = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$ using the quadratic interpolation method with an initial step length of 0.1.

4. a) Show that the Newton’s method finds the minimum of a quadratic function in one iteration.

b) Given the algorithm of Dividon-Fletcher-Powell (DFP) method of optimization of non linear unconstrained optimization problem.

5. Minimize $f(x_1, x_2) = x_1^2 + x_2^2 - 2x_1 - x_2$
Subject to $g_1(x_1, x_2) = x_1 + 4x_2 - 5 \leq 0$
$g_2(x_1, x_2) = 2x_1 + 3x_2 - 6 \leq 0$
$g_3(x_1, x_2) = -x_1 \leq 0$
$g_4(x_1, x_2) = -x_2 \leq 0$
Starting from the point $X_1 = \begin{bmatrix} 1.0 \\ 1.0 \end{bmatrix}$, using gradient projection method.

6. a) Formulate the problem of determining the cross-sectional dimensions of the cantilever beam subjected to a load at the free end for its minimum weight. The maximum permissible bending stress is $\sigma_y$.

b) Define a complementary geometric programming problem.

7. A vessel is to be loaded with three types of items. The maximum allowable weight is 7. The weight per unit of different items and their values are given below. It is required to find the loading which maximizing the values of the vessel without exceeding the weight constraint of 7.

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight/unit</th>
<th>Value per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>70</td>
</tr>
</tbody>
</table>

8. Solve the following problem using Gomary’s cutting plane method.
Maximize $f = 6x_1 + 7x_2$
Subject to $7x_1 + 6x_2 \leq 42$
$5x_1 + 9x_2 \leq 45$
$x_1 - x_2 \leq 4$
$x_i \geq 0$ and integer $i = 1, 2$. 
MODEL QUESTION PAPER
B.E. IV/IV MECHANICAL ENGINEERING – II SEMESTER
(Common with MPIE)
MCH-423 COMPUTER AIDED DESIGN

Time : 3 Hrs.  Max. Marks : 70

Answer question No. 1 and
Answer any FOUR questions from remaining.
Assume suitable missing data wherever necessary.
Answers to question No.1 must be at one place.
All questions carry equal marks.

1. a) Name some CAD system input devices
    b) What is a Programmable controller?
    c) Explain what is meant by an Operating system?
    d) What are the various Mass storage devices?
    e) What is windowing and clipping?
    f) Name the languages that are commonly used in AI. What is inference engine?
    g) Name some popular CAD packages for FEA. What are the application fields of FEA?

2. a) What are the different tasks involved in engineering design? explain each one of them in detail.
    b) Distinguish between hardware and software. what are the advantages of cad workstation? discuss briefly the working of workstation.

3. a) What are graphics standards? Why standards are necessary for computer graphics? Explain various graphics standards.
    b) Explain the need for modeling in CAD and discuss the geometric modeling with suitable examples. Distinguish between wire frame modeling and solid modeling.

4. a) Explain 3 dimensional transformations with examples.
    b) Describe the transformation, which reflects an object about a line L. Perform a 30° rotation of a triangle A(0,0), B(1,1), C(5,2); (i)About the origin and (ii) about P(-1, -2).

5. a) Explain the concept of FEA and FEM modeling.
    b) Explain the process of assembly of element matrices as applicable in FE model.

6. a) Explain 3–dimensional shape description and mesh generation.
    b) Compare the pre and post processing capabilities of three different FEA software packages.

7. Explain the important steps in the development of a program for design and manufacture of a simple plate Cam. Give flow chart and expected output.

8. a) How do you locate centroid and moment of inertia of an object in CAD? Explain it through an example.
    b) What are the applications of Artificial Intelligence in CAD?
MODEL QUESTION PAPER
B.E. III/IV (MECHANICAL ENGINEERING)
II SEMESTER (2001-2002)
DESIGN OF MACHINE ELEMENTS – II

Time : 3 Hrs.
Max. Marks : 70

NOTE:
Answer question No. 1 and
Answer any FOUR questions from remaining.
All questions carry marks.
Assume suitable missing data wherever necessary.
Data books are not allowed.
Answers to question No. 1 must be at one place.

(2 × 7)

1. a) What is conjugate action in gears?
   b) What are the causes of dynamic loads coming on gear tooth?
   c) Distinguish between crossed helical gears and Herringbone gears.
   d) Why I-section is generally selected for connecting rods?
   e) Why are ball and roller bearings called as anti-friction bearings?
   f) Why a plate clutch having two pairs of contact surfaces is termed a single plate clutch?
   g) What are the two main methods of wire rope construction? Mention relative advantages.

(4)

2. a) What are the advantages of Helical gears over Spur gears?
   b) A pair of parallel helical gears consists of 24 teeth pinion rotating at 10000 rpm and transmitting 2.5 KN power to a gear. The speed reduction is 4:1. The normal pressure angle and helix angle are 20º and 23º respectively. Both gears are made of hardened steel with Sut = 600 N/mm². The service factor and factor of safety are 1.5 and 2 respectively. The gears are manufactured for an accuracy of grade-6 condition given by 
   
   \[ e = 8 + 0.63 \phi \] and \( \phi = mn + 0.25 \sqrt{d} \), where \( mn \) is normal module and \( d \) is p.c.d.
   
   Determine the dynamic load and effective load. What is the surface hardness for a Fj = 2?

(10)

3. a) What are whipping stresses in a connecting rod?
   b) Design a connecting rod for a 4-cylinder IC engine having a piston of 100 mm dia, connecting rod length of 313 mm, stroke of piston of 125 mm, normal running speed of 1200 rpm and over speed of 2000 rpm. The maximum explosion pressure in the cylinder is 2.8 N/mm². The weight of reciprocating parts is 11 N. Allowable stress for the material of the connecting rod = 330 N/mm², while the bolt stress 500 N/mm². Sketch and show the dimensions designed.

(10)

4. a) How are the two theories of uniform pressure and uniform wear are applicable to the friction surface of a clutch plate?
   b) An automotive single-plate clutch consists of two pairs of contacting surfaces. The OD of the friction disc is 270 mm. The coefficient of friction is 0.3 and the maximum intensity of pressure is 0.3 N/mm². The clutch is transmitting a torque of 531 N-m. Assuming uniform wear, determine the inner diameter and the axial force required to keep the clutch engaged.

(10)

5. a) What is self-locking in brakes?
   b) An internal-expanding shoe brake shown in figure has a face width of 50 mm and coefficient of friction of 0.4. The maximum intensity of pressure allowed is 0.8 N/mm². Determine the actuating force and the torque capacity of the brake.

(10)
6. a) Distinguish between thick film lubrication and thin film lubrication. What is bearing modulus? (4)
   b) The radial load in a full hydrodynamic bearing is 25 KN and journal speed is 900 rpm. The unit bearing pressure is 2.5 MPa, bearing has an L/D ratio of 1:1. The viscosity of the lubricant is 20 Cp and radial clearance of 0.15 mm. Determine the bearing dimensions and cooling oil rate of flow. (10)

7. a) What are bending stresses in wire ropes? Explain the term “Slicing” of ropes. (4)
   b) Wire ropes of 6 × 19 type with tensile designation 1230 and nominal diameter 10 mm are used for a hoist. The mass of wire rope is 345 N per 100 m, while the braking load is 38 KN. The weight of hoist along with the material is 10 KN, which is raised through a distance of 3 m. The maximum acceleration during operation is limited to 1 m/sec^2. Neglecting bending stress, determine the number of ropes required if Fs = 10. (10)

8. a) What is chordal action in chain drivers? (4)
   b) A simple roller chain No. 10 B is used to drive a line shaft from an electric motor which runs at 1400 rpm while the line shaft rotates at 350 rpm. The number of teeth on the driving sprocket wheel are 19. For smooth operation without shock, determine the rated power capacity, tension in the chain and factor of safety based on breaking load. Given power rating of 10 B chain as 11.07 KW, Ks = 1, K1 = 1 and K2 = 1.11.
MODEL QUESTION PAPER
B.E. IV/IV MECHANICAL – I SEMESTER
(Common to Mechanical and MPIE)
HEAT AND MASS TRANSFER

Time : 3 Hrs. Max. Marks : 70

Answer question No. 1 and
Answer any FOUR questions from remaining.
Assume suitable missing data wherever necessary.
Answers to question No.1 must be at one place.
All questions carry marks.
Heat transfer data book is permitted.

1. a) Determine the thermal conductivity of a plate with area A = 0.5 m² and thickness L = 0.02 m with its surfaces maintained at 60º C and 20º C. Given net heat is 70 KW. Find the thermal conductivity of the plate.
b) Define Biot and Fourier numbers.
c) What is Reynolds-Colburn’s analogy.
d) Draw the temperature distribution in a double pipe heat exchanger when operated under parallel flow and counter flow conditions.
e) State Fick’s law of diffusion and define various symbols used and give their units.
f) Differentiate between mechanisms of heat transfer by forced and free convection.
g) Define monochromatic and total emission power of a body.

2. a) The thermal conductivity of a material varies as \( K = K_0(1 + aT + bT^2) \) while \( K_0, a, b \) are constants and T is the temperature in ºC. Obtain an expression for the thermal resistance per unit surface area of a plane wall constructed from this material.
b) A copper cable of 25 mm diameter has an electrical resistance of 0.005 ohm/m and it is used to carry an electrical current of 250 amps. The cable is exposed to ambient air at 20ºC and the associated convection coefficient is 25 w/m²K. What are the surface and center line temperatures of the copper cable? The thermal conductivity of copper is 380 w/mK.

3. a) Define fin efficiency and fin effectiveness. Obtain an expression for fin efficiency for an insulated tip condition.
b) A long cylindrical aluminium pipe of diameter 100 cm initially at a temperature of 773 K has air stream at 373 K blown over it. For the pipe, density \( \rho = 2707 \text{ kg/m}^3 \), specific heat \( C_p = 896 \text{ J/kg K} \) and thermal conductivity \( K = 204 \text{ w/mK} \), convective heat transfer coefficient \( h = 80 \text{ w/m}^2\text{K} \). Determine the time required for the pipe to reach 473 K.

4. a) Air at 20º C and atmospheric pressure is flowing past a flat plate at a velocity of 3 m/sec. The plate is heated over its entire length to a uniform temperature of 60ºC. Calculate the heat transfer from the first 30 cm length of the plate (Assume total length of the plate 1 m). Also estimate the drag force exerted on the first 30 cm length of the plate. Use the analogy between fluid friction and heat transfer.
b) Define bulk mean temperature in a tube flow.

5. a) Estimate the heat transfer from a 40 W incandescent bulb at 125ºC to quiescent air at 25ºC. Approximate the bulb as a sphere of 50 mm diameter. What percent of the power is lost by free convection? Use the correlation:
\[ \text{Nu} = 0.60(\text{Gr}.\text{Pr})^{0.25} \]
b) Water flows through a tube of 2 cm diameter at a rate of 90 lit/hr. Determine whether the flow is laminar or turbulent. Also estimate the entrance length. [Take the kinematic viscosity of water as \( 1 \times 10^{-6} \text{ m}^2/\text{sec} \)].

6. a) Prove that the intensity of radiation is given by \( I_b = \frac{E_b}{\pi} \).
b) An enclosure measures 1.5 m × 1.75 m with a height of 2 m. Under steady state equilibrium conditions, the walls and ceiling are maintained at 525 K and floor at 400 K. Determine the net radiation to floor.

\[ \varepsilon_1 \text{ (emissivity of ceiling and walls)} = 0.85 \]
\[ \varepsilon_2 \text{ (emissivity of floor)} = 0.75. \]

7. a) A parallel flow heat exchanger is to be designed to cool oil \((C_p = 2.0 \text{ KJ/kg K})\) from 125°C to 85°C by the flow of water. The water flows at the rate of 75 kg/min and gets heated from 40°C to 75°C. What heat exchanger area is required for an overall heat transfer coefficient of 0.35 kW/m² K? A change in the operating conditions occur for the same heat exchanger and the water flow rate drops to 50 kg/min for the same oil flow rate. Work out the exit temperature of the oil and water under the changed conditions.

b) Show that effectiveness \(\varepsilon = \frac{\text{NTU}}{1 + \text{NTU}}\) for counter flow heat exchanger.

8. a) Saturated steam at a pressure of 100 KPa condenses on the outside surface of a horizontal pipe of 2 cm diameter. The surface temperature of the pipe is maintained at a temperature of 94.37°C by circulating water through it. Determine the amount of steam condensed per hour, per meter of the tube length.

b) Explain the phenomenon of nucleate boiling. List the factors that affect the nucleate boiling.
MODEL QUESTION PAPER
B.E. IV/IV MECHANICAL – I SEMESTER

FLUID MACHINERY & SYSTEMS

Time : 3 Hrs.  
Max. Marks : 70

Answer question No. 1 and
Answer any FOUR questions from remaining.
Assume suitable missing data wherever necessary.
Answers to question No.1 must be at one place.

1. a) Write short note on jet propulsion. (7 × 2)
b) What is draft tube? Write down its applications.
c) Define the terms
   i) specific speed
   ii) unit speed
   of a turbine.
d) What is priming? Why it is necessary?
e) What is the function of an air vessel in reciprocating pump?
f) Explain two methods adopted to convert kinetic energy of water into pressure energy
   in a centrifugal pump.
g) Explain the working of hydraulic accumulator.

2. a) Derive the expression for the force exerted by the jet on stationary inclined flat plate. (6)
b) A 7.5 cm diameter jet having a velocity of 30 m/s strikes a flat plate, the normal of
   which is inclined at 45º to the axis of the jet. Find the normal pressure on the plate (i)
   when the plate is stationary, (ii) when the plate is moving with a velocity of 15 m/s
   and away from the jet. Also determine the power and the efficiency of the jet when
   the plate is moving. (8)

3. a) What is reaction turbine? How does it differ
   from an impulse turbine? Give examples
   of each. (4)
b) A 137 mm diameter jet of water issuing from a nozzle impinges on the buckets of a
   Pelton wheel and the jet is deflected through an angle of 165º by the buckets. The
   head available at the nozzle is 400 m. Assuming coefficient of velocity as 0.97, speed
   ratio as 0.46, and reduction in relative velocity while passing through buckets as 15%,
   find the power developed. (10)

4. a) What is governing of turbines? Why it is necessary? What is the effect, if the
   turbines
   are not governed? (5)
b) The hub diameter of a Kaplan turbine, working under a head of 12 m, is 0.35 times
   the diameter of the runner. The turbine is running at 100 rpm. If the vane angle of the
   extreme edge of the runner at outlet is 15º, and the flow ratio 0.6, find
   i) diameter of the runner
   ii) discharge through the runner.
   The velocity of whirl at outlet is given as zero. (9)

5. a) Make a note on characteristic curves of hydraulic turbines under constant head. (6)
b) A turbine is to operate under a head of 25 m at 200 rpm. The discharge is 9 m³/sec. If
   the efficiency is 90%, determine the performance of the turbine under a head of 20 m. (8)

6. a) Define cavitation. What are the effects of cavitation in hydraulic machines? (6)
b) The internal and external diameters of the impeller of a centrifugal pump of 20 cm
   and 40 cm respectively. The pump is running at 1200 rpm. The vane angles of the
   impeller at inlet and outlet are 20º and 30º respectively. The water enters the impeller
   radially and velocity of flow is constant. Determine the work done by the impeller per
   kg of water. (8)

7. a) Explain the working of single acting reciprocating pump with a neat sketch. (5)
b) A single acting reciprocating pump has piston diameter 12.5 cm, and stroke length 30 cm. The center of the pump is 4 m above the water level in the sump. The diameter and length of suction pipe are 7.5 cm and 7 m respectively. The separation occurs if the absolute pressure head in the cylinder during suction stroke falls below 2.5 m of water. Calculate the maximum speed at which the pump can run without separation. Take atmospheric pressure head as 10.3 m of water.

8. a) Make a note on closed loop servo system.
   b) Explain the working of a hydraulic torque converter unit.
MODEL QUESTION PAPER
B.E. III/IV MECHANICAL – I SEMESTER
ENGINEERING ECONOMICS
(Common for Mechanical and MPIE)
From 1999-2000 admitted batch

Time : 3 Hrs.
Max. Marks : 70

NOTE : Answer Part ‘A’ and any FOUR questions from Part ‘B’.
All questions carry marks.
Missing data if any may be assumed suitably.
Answers to Part ‘A’ must be at one place.

PART – A
1. a) Explain the difference between utility and usefulness with an example.
b) Define the “Law of demand”.
c) Distinguish between private limited company and public limited company.
d) What is meant by imperfect competition?
e) What are different kinds of overheads?
f) Graphically show a break even point.
g) What a trading account shows?

PART – B
2. What is elasticity of demand? Explain various methods of estimating elasticity of demand.
3. Explain the features, advantages and disadvantages of single proprietary concern and partnership.
4. Explain how price is determined under monopoly.
5. Explain various theories of interest and how rate of interest is determined under these theories.
6. Explain the concepts of unit costing and job costing.
7. What is Depreciation? What are various methods of depreciation?
8. From the following Trial Balance of M/s Srikrishna Enterprises prepare final accounts for the year ending on 31st March, 2000.

Dr., balances Rs. Cr. balances Rs.
Bank 7,500 Capital 2,00,000
Purchases 34,96,000 Bills payable 50,000
Salaries 21,000 Loan 1,00,000
Carriage on sales 2,500 Sales 36,00,000
Carriage on purchases 2,000 Discount 2,000
Lighting 1,500 Commission 500
Buildings 1,35,000 Sundry creditors 1,00,000
Rent and Taxes 2,000
Sundry debtors 40,000
Furniture 30,000
Cash in hand 1,250
Bills receivable 7,500
Op. stock 3,06,250

MODEL QUESTION PAPER-Mechanical Engineering
M.E. (INDUSTRIAL ENGINEERING) - EVENING COURSE - III SEMESTER

● Page 97 For Admitted batch of 2014-2015
IE 301E  TOTAL QUALITY MANAGEMENT
(Four-Semester Evening Course -Credit System- w.e.f. 2007-2008)

Time : 3 Hrs.  Max.
Marks : 70

Answer any FIVE questions.
All questions carry equal marks.

1. Describe the total quality management philosophy.
2. What is the role of top management in setting a road map for quality improvement in an organization?
3. What are the advantages of using quality function deployment? What are the key ingredients that are necessary for its success?
4. What are the different types of quality audits? Discuss each and identify the context in which they are used.
5. Discuss the emerging role of ISO 9000 standards in the global economy.
6. Describe the steps of benchmarking relative to a company of your choice.
7. a) State the merits and demerits of JIT production system.
   b) Explain quality circles.
8. Answer any THREE of the following:
   a) Kaizen.
   b) Taguchi method.
   c) QC tools.
   d) Quality policy.
   e) Designing for quality.
Question No. 1 is compulsory and to be written at one place
Answer any FOUR from the remaining
All questions carry equal marks
Use of statistical tables is allowed

1. (a) Distinguish between quality loss and quality cost.
   (b) What is ‘off-line’ quality control?
   (c) How type-I error is controlled?
   (d) What is a run with respect to a control chart?
   (e) Give two examples for nominal the better type product specifications.
   (f) What is process capability ratio?
   (g) Mention the difference between ATI and ASN.

2. (a) Explain the concept of six sigma.
   (b) An $\bar{X}$ chart with three sigma limits has parameters as follows:
       \[\begin{align*}
       UCL &= 104 \\
       CL &= 100 \\
       LCL &= 96 \\
       n &= 5
       \end{align*}\]
       Suppose the process quality characteristic being controlled is normally distributed
       with a true mean of 98 and a standard deviation of 8. What is the probability that the
       control chart would exhibit lack of control by at least the third point plotted?

3. (a) What is the basis for using 3-sigma limits in control charts? Do you justify the
       same for attribute control charts?
       (b) A fraction nonconforming control chart is to be established with a centre line of
           0.01 and two-sigma control limits. How large should the sample size be if the lower
           control limit is to be nonzero?

4. (a) Explain the construction and use of demerit control chart.
       (b) A control chart for defects per unit $u$ uses probability limits corresponding to
           probabilities of 0.975 and 0.025. The central line on the control chart is at
           $u' = 2.0$. Determine the position of the control limits when $n = 5$.

5. (a) How do you estimate the process capability index using a control chart?
       (b) The roughness of the ground surface of a component can not exceed 0.02 units. A
           random sample of components ground by a surface-grinding machine yielded the
           following estimates:
           Mean roughness = 0.01 units
           Standard deviation = 0.003 units
           Compute the $C_p$ index of the process and estimate the proportion of defectives to be
           generated by the process, assuming that the surface roughness measurements follow
           normal distribution.

6. (a) Explain the concept of an ideal O.C curve.
       (b) Draw the O.C curve for the following single sampling plan:
           $n = 300$ and $c = 5$.
           If the incoming quality is 1%, find the AOQ.

7. (a) How to obtain AOQL for a given sampling plan?
       (b) For the following data choose suitable single and double sampling plans:
           $N = 900$, LTPD = 5.0%, $\beta = 0.1$, process average = 0.75%.
           Explain the working of both plans.
8. Write short notes on any TWO of the following:
   (a) Taguchi’s quality loss function
   (b) Quality costs
   (c) Deming’s quality philosophy.