

# Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

## Branch- Common to All Discipline

### New Scheme Based On AICTE Flexible Curricula

<b>BT301</b>	<b>Mathematics-III</b>	<b>3L-1T-0P</b>	<b>4 Credits</b>
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**OBJECTIVES:** The objective of this course is to fulfill the needs of engineers to understand applications of Numerical Analysis, Transform Calculus and Statistical techniques in order to acquire mathematical knowledge and to solving wide range of practical problems appearing in different sections of science and engineering. More precisely, the objectives are:

- To introduce effective mathematical tools for the Numerical Solutions algebraic and transcendental equations.
- To enable young technocrats to acquire mathematical knowledge to understand Laplace transformation, Inverse Laplace transformation and Fourier Transform which are used in various branches of engineering.
- To acquaint the student with mathematical tools available in Statistics needed in various field of science and engineering.

**Module 1: Numerical Methods – 1: (8 hours):** Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsi method. Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae.

**Module 2: Numerical Methods – 2: (6 hours):** Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules. Solution of Simultaneous Linear Algebraic Equations by Gauss's Elimination, Gauss's Jordan, Crout's methods, Jacobi's, Gauss-Seidal, and Relaxation method.

**Module 3: Numerical Methods – 3: (10 hours):** Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. RungeKutta method of fourth order for solving first and second order equations. Milne's and Adam's predictor-corrector methods. Partial differential equations: Finite difference solution two dimensional Laplace equation and Poission equation, Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for wave equation.

**Module 4: Transform Calculus: (8 hours):** Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace Transform method, Fourier transforms.

**Module 5: Concept of Probability: (8 hours):** Probability Mass function, Probability Density Function, Discrete Distribution: Binomial, Poisson's, Continuous Distribution: Normal Distribution, Exponential Distribution.

#### Textbooks/References:

1. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company, 2nd Edition, Reprint 2012.
2. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.
3. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.

5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008.
7. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
8. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
9. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968. Statistics

New Scheme Based On AICTE Flexible Curricula

Mechanical Engineering, III-Semester

ME302 Thermodynamics

**Objectives:** To develop ability and gain insight into the process of problem-solving, with emphasis on thermodynamics. Specially in following manner:

Apply conservation principles (mass and energy) to evaluate the performance of simple engineering systems and cycles, · Evaluate thermodynamic properties of simple homogeneous substances, · Analyze processes and cycles using the second law of thermodynamics to determine maximum efficiency and performance, · Discuss the physical relevance of the numerical values for the solutions to specific engineering problems and the physical relevance of the problems in general, and · Critically evaluate the validity of the numerical solutions for specific engineering problems.

**Outcomes :** At the completion of this course, students should be able to

1. find values of thermodynamic properties in tables;
2. draw thermodynamic processes on pressure-temperature, pressure-volume, or temperature-volume diagrams;
3. use compressibility charts;
4. calculate expansion or compression work in a closed system;
5. use conservation of mass to determine the change in mass of a system

**Basic Concepts & Laws of Thermodynamics :** Basic concepts: Property, Equilibrium, State, Process, Cycle, Zeroth law of thermodynamics, Heat and work transfer. First law of thermodynamics- first law applied to various systems steady flow process, limitations of first law of thermodynamics.

Second law of thermodynamics, heat engine, heat reservoir, Refrigerator, heat pump, Carnot's cycle, statements of second law Reversible and irreversible processes, consequence of second law, Clausius

Inequality , Entropy, T-S diagrams, Available & Unavailable energy Availability Concept .

**Properties of Steam :** Pure Substance, Phase, Phase-transformations, formation of steam, properties of steam, PVT surface, HS,TS,PV,PH,TV diagram, processes of vapor measurement of dryness fraction, Use of steam tables and Mollier chart.

**Air standard cycles:** Carnot, Otto, Diesel, Dual cycles and their comparison, Brayton cycle, Non reactive gas mixture, PVT relationship, mixture of ideal gases, properties of mixture of ideal gases, internal energy, Enthalpy and specific heat of gas mixtures.

**Fuels & combustion :** Actual & theoretical Combustion processes , Enthalpy of formation & enthalpy of reaction, first law analysis of reacting systems, Adiabatic flame temperature , Basic concept of Third Law of thermodynamics .

Steam Tables Mollier Charts & tables connected to reactive systems are allowed in Examination hall .

**EVALUATION**

Evaluation will be continuous an integral part of the class as well through external assessment.

**References:**

1. P.K.Nag; Engineering Thermodynamics; Mc Graw Hills Fifth Edition
- 2 Cengel Y; Thermodynamics; MC Graw Hills ,Eight Edition
- 3 Kross & Potter Thermodynamics for Engineers CENGAGE Learning
- 4 Moran, Shapiro ,Boettner Principles of Engineering Thermodynamics Wiley student edition
- 5 P Chattopadhyya , Engineering Thermodynamics Second Edition,OXFORD University Press
- 5 Zemansky Heat & Thermodynamics , Eight Edition , Mc Graw Hills India Education
6. Achuthan M; Engineering Thermodynamics by, PHI India.
- 7 R Yadav Applied Thermodynamics , Central Publishing house Allahabad

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, III-Semester**

**ME303 Materials Technology**

1. Solidification of metals , Crystallisation, Crystal and amorphous , different types of bonds in different metals, Crystallography. Stability and metastability of metals. Different mechanical properties of metals and other engineering materials like strength, hardness, elasticity, plasticity, Malleability, Ductility, Creep, Fatigue etc. Introduction to industrial metals, steels and prevailing manufacturing methods by manufacturers.
2. Cooling curves, Isomorphous, Utectic, Eutectoid , Eutectoid solid solution, Peritectic and other phase diagrams, Alloying , Characteristics of alloying elements, Iron – Carbon phase diagram, T-T-T diagrams, Types of Cast Iron. Types of Stainless Steels, Elastic, anelastic and Viscoelastic behaviour.
3. Heat treatment of metals, Based on phase diagram and T-T-T-Diagram the heat treatment of various metals, Bulk heat treatments, surface heat treatments,Case carburising, Types of Annealing, Normalising,Spheroidising, Phase Transformations like Parlite, Cementite, Austenite, Troostite,Bainite,Hard and soft Martensite etc. Laser hardening, Cyniding, Boriding, Nitriding, Flame hardening, Ion implantation, Etc. Heat treatment cycles. Metallographic studies, Optical Microscope, Electron Microscope.
4. Destructive and non-destructive testing methods, Tensile test, Compression test, shear test, bend test, Different types of Hardness tests, Impact tests, Fatigue tests, Hardenability test. Fracture analysis, NDT Methods. Different properties of Steels, Aluminium and it's alloys, Copper and it's alloys, Manganese and it's alloys, Chromium and it's alloys, Nickel and it's alloys.
5. Chemical Analysis of different alloying elements in commercial metals, C, Fe, Cr, Ni, Mn, Mg, S, P, Co, Mo, Etc. Different chemical reagents, Equipments , Volumetric and Gravimetric analysis, Spot test, Colorimetric methods, Optical and spectrophotometric analysis.

**References :**

1. V. Raghwan, Material Science
2. G.E.Dieter, Mechanical Metallurgy
3. P Chalmers, Physical Metallurgy
4. R. C.Rollason, Metallurgy for mechanical engineers

## List of experiments :

1. Metallographic studies – Study of Optical microscope, Optically flat surface preparation, etching reagents, Grain size- ASME no., micro structures, Image analysis, Standard specimen,
2. Carbon, sulphur, Phosphorus determination, Strauhlin's apparatus, Eggert's Method in different samples.
3. Hardness and Hardenability test, Jeremy Cony test. Soft and hard Martensite.
4. Different heat treatment cycles using electric furnace [ Programmable preferred ], Annealing, Case carburising, Normalising, etc.
5. Gravimetric / Volumetric - chemical analysis of alloying elements like, Cr, Ni, Mn, Si etc.
6. Study of different instrumental method of analysis, spectrophotometers, Differential Scanning calorimeter,
7. Spot test for quick assessment of alloying elements like Mn, Cr, Ni, etc.
8. Experiments / study of Non Destructive Methods, Ultrasonic test, Magnetic particle inspection, Dye penetration test, Eddy current test, Radiography test.
9. Cupping test / formability test for sheet metal

New Scheme Based On AICTE Flexible Curricula

Mechanical Engineering, III-Semester

ME304 Strength of Material

**Objectives :**

To familiarize the students with the fundamentals of deformation, stresses, strains in structural elements.

**Outcomes :**

At the completion of this course, students should be able to

1. Know the concepts of stress and strain.
2. Analyze the beam of different cross sections for shear force, bending moment, slope and deflection.
3. Understand the concepts necessary to design the structural elements and pressure vessels.

**Stress and strain:** stresses in members of a structure, axial loading, normal stress, shear stress, analysis of simple structures, stepped rods, members in series and parallel: stress strain diagram, Hooke's law, stress due to temperature, Poisson's ratio, Bulk modulus, shear strain, relation among elastic constants, residual stress, fiber reinforced composite materials, strain energy under axial loads and stresses due to impact of falling weights. Transformation of stress and strain, principal stresses, normal and shear stress, Mohr's circle and its application to two and three dimensional analysis.

**Bending:** pure bending, symmetric member, deformation and stress, bending of composite sections, eccentric axial loading, shear force and BM diagram, relationship among load, shear and BM, shear stresses in beams, strain energy in bending, deflection of beams, equation of elastic curve, Macaulay's method and Area moment method for deflection of beams.

**Torsion in shafts:** Tensional stresses in a shafts, deformation in circular shaft, angle of twist, stepped and hollow transmission shafts.

**Theories of failures:** maximum normal stress & shear stress theory; maximum normal and shear strain energy theory; maximum distortion energy theory; application of theories to different materials and loading conditions.

**Columns & struts :** stability of structures, Euler's formula for columns with different end conditions, Rankine's formula.

**EVALUATION**

Evaluation will be continuous an integral part of the class as well through external assessment.

**References:**

1. Beer FP, Johnson Mechanics of Materials ,Sixth Edition ;Mc Graw Hills
2. Debabrata Nag & Abhijet Chanda :Strength of Materials : Wiley
3. Rattan; Strength of materials;Second Edition , Mc Graw Hills
4. Nash William; Schaum's Outline Series; forth Edition Strength of Materials;Mc Graw Hills
5. Singh Arbind K; Mechanics of Solids; PHI
6. Sadhu Singh; Strength of Materials; Khanna Pub.
7. R Subramannian , Strength of materials OXFORD University Press ,Third Edition .
8. S Ramamurthum , Strength of materials , Dhanpat Rai

**List of experiments :**

1. Standard tensile test on MS and CI test specimen with the help of UTM
2. Direct/ cross Shear test on MS and CI specimen
3. Transverse bending test on wooden beams to obtain modulus of rupture
4. Fatigue test
5. Brinell Hardness tests
6. Vicker hardness test
7. Izod/Charpy test
- 8 Rockwell Hardness test



**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, III-Semester**

**ME 305 Manufacturing Process**

**Objectives :**

To make the students aware of different manufacturing processes like casting, metal forming, metal cutting and gear manufacturing.

**Outcomes :**

1. Concepts of casting Technology.
2. Mechanical working of metals.
- 3 Concepts of welding process
- 4 Concept of forging methods
- 5 Understanding press working .

**Casting :** Types of casting process .Molding and Foundry core sands and their properties, gating, runners, risers, solidification, defects and elimination, molding machines, centrifugal casting, dye casting, shell molding; Lost wax molding; continuous casting; cupola description and operation.

**Welding:** Types of welding ,Gas welding method, flames, gas cutting, Electric arc welding, AC and DC welding machines and their characteristics, flux, electrodes, submerged arc welding, TIG & MIG welding; pressure welding; electric resistance welding spot, seam and butt welding; Thermit chemical welding; brazing and soldering, welding defects & remedies .safety precautions .

**Pattern Making:** Types of patters, Pattern and pattern making, pattern allowances; pattern design considerations, core, core boxes .

**Forging:** types of forging operations Theory and application of forging processes description; , drop and horizontal forging machines .

**Press working:** Description and operation of processes, process of shearing, punching, piercing, blanking, trimming, perfecting, notching, lancing, embossing, coining, bending, forging and drawing; press, tool dies, auxiliary equipment, safety devices, stock feeders, scrap cutters, forces, pressure and power requirements .

**Rolling:** Types of Rolling operations ,General description of machines and process; rolling of structural section plates and sheets; hot and cold rolling techniques

**Metal Machining :** Basics of Lathe machines , operations & components ,working principle of Shaper & planner ,Introduction to milling ,grinding and drilling machines .

**List of Experiments :**

1. Study of tools used for various manufacturing processes , study includes application & live demonstration of hand and machine tools .
2. Hands on Exercise on Pattern Making
3. Performance on Metal Casting of Simple component
4. Performance on Welding of simple work piece (Example Arc and Resistance Welding)
5. Exercise Problems on Welding
6. Exercise problems on Casting
7. Study of forging machine & demonstration of various operations of forging .
8. Study of Hydraulic ,Pneumatic presses & demonstration of piercing, slitting, deep drawing operations on press machine .

## **EVALUATION**

Evaluation will be continuous an integral part of the class as well through external assessment.

### **References:**

1. Anderson and Tetro; Shop Theory; Mc Graw Hills
2. Kaushish JP; Manufacturing Processes; PHI Learning.
3. Kalpakjian Producting Engineering PEARSON Education
4. Chapman; Workshop Technology
5. Philip F Ostwald ; Manufacturing Process & systems : John Wiley
6. Raghuvanshi; Workshop Technology ; Dhanpat Rai.
7. Hajra Choudhary; Workshop Technology:, Vol I

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, III-Semester**

**ME306 Thermal Engg Lab**

1. To determine volumetric and isothermal efficiencies of a single stage compressor.
2. Study of two stage air compressor with intercooler.
3. To determine volumetric and isothermal efficiencies of a two stage compressor.
4. Study of different types of boilers and their classifications.
5. Study of different types of high pressure boilers.
6. To determine the performance of boiler.
7. Temperature measurements, Pyrometers and thermography.
8. Thermocouples, Temperature sensors, study and calibration.
9. Study and experiments on ORSAT apparatus.
10. Experiments on calorific value of different fuels and analysis of exhaust gases.

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, V-Semester

#### ME501- Internal Combustion Engines

##### **Unit 1: Introduction of IC Engine:**

Internal Combustion Engine: S.I. and C.I. engines of two and four stroke cycles, real cycle analysis of SI and CI engines, determination of engine dimensions, speed, fuel consumption, output, mean effective pressure, efficiency, factors effecting volumetric efficiency, heat balance, performance characteristics of SI and CI engines, cylinder arrangement, firing order, power balance for multi-cylinder engines .

##### **Unit 2: Combustion in SI engines:**

Flame development and propagation, Pressure-Crank Angle diagram, Stages of Combustion ignition lag, effect of air density, temperature, engine speed, turbulence and ignition timings, physical and chemical aspects, abnormal Combustion, effect of engine and fuel variables on abnormal combustion, pre-ignition, its causes and remedy, salient features of various type combustion chambers.

##### **Unit 3: Combustion in CI Engines:**

Various stages of combustion in CI Engines, delay period, diesel knock, knock inhibitors, salient features of various types of combustion chambers. Fuel injection in CI engine, Working Principle of fuel pump & fuel injectors, types of nozzles.

Fuel injection in SI engine (MPFI, TBI, CRDI ), Theory of carburetion, Solex Carburetor, simple problems on carburetion. Fuel metering in CI engines

##### **Unit 4: Fuel:**

Classification of IC Engine fuels, Desirable characteristics of SI & CI engine fuels, Rating of SI & CI engine fuels, Alternative fuels for SI and CI engine (liquid, gaseous, hydrogen, LPG, CNG, Biogas etc.), Air requirement, Analysis of combustion products, HHV and LHV of fuels.

##### **Unit 5: Supercharging & Turbo charging:**

Methods of supercharging, & turbo charging Effects of super charging and turbo charging. Engine Modifications for supercharging, supercharging of two stroke engines. microprocessor controlled supercharging. Cooling & lubrication of SI & CI Engines.

##### **References:**

1. J.B. Heywood. Internal combustion Engines, Wiley
2. Ganeshan V; Internal Combustion engines; TMH
3. Mathur M L & Sharma RP; A. Course in IC engines; Dhanpat Rai
4. R Yadav, Internal Combustion Engines
- 5 Halderman JD and Mitchell CD; Automotive Engines theory and servicing; Pearson
6. DomKundwar; Internal Combustion Engines; Dhanpat Rai Publications
7. Taylor GF; Internal Combustion Engines Theory & Practice; MIT Press
8. Richard Stone; Introduction to IC Engines; Society of Automotive Engr (Palgrave Mc Millan)

**List of Experiments (please expand it);**

1. Determination of Valve timing diagram
2. Load test on Petrol Engine
3. Heat Balance of SI engine
4. Heat Balance of CI Engine
5. Study of Battery Ignition system and Electronic Ignition System
6. Study of Diesel fuel pump
7. Study of Diesel fuel injectors
8. Study of Carburetors
9. Study of Fuel Injection system in SI Engine
10. Study of lubricating system in CI Engine

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, V-Semester

#### ME502- Mechanical Vibrations

**Unit 1: Fundamental Aspects of Vibrations:** Vibration, main causes, advantages and disadvantages; engineering applications of vibration and noise; vector method of representing harmonic motion; characteristics of vibration, harmonic analysis and beats phenomenon, work done by harmonic forces on harmonic motion; periodic, non-harmonic functions- Fourier series analysis; evaluation of coefficients of Fourier series; elements of vibratory system; lumped and distributed parameter systems. **Undamped Free Vibrations:** Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration. Systems involving angular oscillations: the compound pendulum.

**Unit 2: Damped Free Vibrations: Viscous damping:** coefficient of damping; damping ratio; under damped, over damped and critically damped systems; logarithmic decrement; frequency of damped free vibration; Coulomb or dry friction damping; frequency, decay rate and comparison of viscous and Coulomb damping; solid and structural damping; slip or interfacial damping.

**Unit 3: Harmonically excited Vibration:** One degree of freedom- forced harmonic vibration; vector representation of forces; excitation due to rotating and reciprocating unbalance; vibration Isolation, force and motion transmissibility; absolute and relative motion of mass (Seismic Instruments ). Whirling Motion and Critical Speed : Whirling motion and Critical speed : Definitions and significance. Critical speed of a vertical , light flexible shaft with single rotor : with and without damping . Critical speed of a shaft carrying multiple discs (without damping ), Secondary critical speed.

**Unit 4: Systems With Two Degrees of Freedom :** Un-damped free vibration of 2 d.o.f and Principal modes of vibration; torsion vibrations; Forced, Un-damped vibrations with harmonic excitation ; Coordinate coupling; Dynamic vibration absorber; torsion Vibration Absorber; Pendulum type of dynamic vibration.

**Unit 5: Noise Engineering Subjective response of sound:** Frequency and sound dependent human response; the decibel scale; relationship between, sound pressure level (SPL), sound power level and sound intensity scale; relationship between addition, subtraction and averaging, sound spectra and Octave band analysis; loudness; weighting networks; equivalent sound level, auditory effects of noise; hazardous noise, exposure due to machines and equipments; hearing conservation and damage risk criteria, daily noise doze.

Noise: Sources, Isolation and Control: Major sources of noise on road and in industries, noise due to construction equipments and domestic appliances, industrial noise control, strategies-noise control at source (with or without sound enclosures), noise control along the path (with or without partitions and acoustic barriers ); noise control at the receiver, ear defenders, earplugs, semi-insert protectors.

### **References:**

1. Ambekar A.G., 'Mechanical Vibrations and Noise Engineering; PHI
2. Meirovitch Leonard; Element of Vibration Analysis; TMH
3. Dukikipati RV Srinivas J Text book of Mechanical Vibrations; PHI
4. Kelly SG and kudari SK; Mechanical Vibrations; Schaum Series;TMH
5. Thomson , W.T., Theory of Vibration with Applications , C.B.S Pub & distributors .
6. Singiresu Rao, 'Mechanical Vibrations , Pearson Education .
7. G.K. Grover, ' Mechanical Vibration , Nem chand and Bross , Roorkee

### **List of experiments (please expand it);**

- 1.To find out effect of load on natural frequency of vibrations of a lever pin supported at one end carrying adjustable load on a vertical screwed bar and spring supported at some intermediate point (i) When the dead weight of rods is neglected and (ii) when their dead weight is taken into account .
2. To find out frequency of damped free vibration and rate of decay of vibration-amplitude in the system.
3. To find out natural frequency and damped free frequency of a torsion pendulum and , hence to find out coefficient of damping of the oil ;
4. To observe the phenomenon of 'whirl' in a horizontal light shaft and to determine the critical speed of the shaft.
5. To observe the mode shapes of a spring-connected, double pendulum and hence to demonstrate the phenomenon of beats.
6. To demonstrate the principle of tuned Undamped Dynamic Vibration Absorber and to determine the effect of mass-ratio (of main and auxiliary mass) on the spread of the resulting natural frequencies;
7. To take measurements of sound Pressure Level (SPL) and to carry out octave band analysis of a machine using Noise Level Meter.

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, V-Semester

#### Departmental Elective ME- 503 (A) Mechatronics

**UNIT – 1 INTRODUCTION:** Definition of Mechatronics, Multi-disciplinary scenario, origins. Evaluation of Mechatronics, An over view of mechatronics, Design of mechatronics system. Measurements system and function of main elements of measurement systems. Need for mechatronics in industries. Objectives, advantages and disadvantages of mechatronics. Microprocessor based controllers. Principle of working of engine management system, automatic washing machine.

**UNIT – 2 REVIEW OF TRANSDUCERS AND SENSORS:** Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors. **MICROPROCESSOR:** Introduction, Microprocessor based digital control. Digital number system, binary and hexadecimal number system, Logic functions, Data word representation basic Elements of control systems.

**UNIT 3 : MICROPROCESSOR ARCHITECTURE:** 8085A processor architecture Terminology-such as, CPU, memory and address, ALU, assembler, data, registers, Fetch cycle, write cycle, state, bus interrupts. Micro controllers – difference between microprocessor and micro controllers. Requirements for control and their implementation in micro controllers. Classification of micro controllers.

#### Unit 4

**ELECTRICAL ACTUATORS:** Actuator and actuator system. Classifications of actuator system with examples. Mechanical switches. Concept of bouncing Methods of Preventing bouncing of mechanical switches. Solenoids, Relays. Solid state switches – Diodes, Thyristors, Triacs, Transistors, Darlington pair. Electrical actuator. Principle, construction and working of AC, DC motors, stepper motors, permanent motors, servomotors, Servo systems and control

**HYDRAULIC ACTUATORS:** Valves – Classifications, Pressure Control Valves – Pressure relief valves, Pressure regulating/reducing valves, Pressure sequence valve. Flow control valves – Principle, needle valve, globe valve. Direction control valve –sliding spool valve, solenoid operated.

**Unit 5 : SINGLE CONDITIONING:** Concept, necessity, op-amps, protection, filtering, wheat stone bridge – Digital Signals – Multiplexer. Data acquisition – Introduction to digital signal processing – Concepts and different methods.



## REFERENCE BOOKS:

1. **Mechatronics** – Principles, Concepts and applications – Nitaigour and Premchand, Mahilik – Tata McGraw Hill -2003
2. **Mechatronics** – W. Bolton, Pearson Education Asia -2<sup>nd</sup> Edition, 2001.
3. **Introduction to mechatronics and measurement systems** –David G. Alciatore & Michel BiHstand – Tata McGraw Hill –2000
4. **Mechatronics** – H.D. Ramachandra – Sudha Publication -2003 **Mechatronics** by HMT Ltd. – Tata McGrawHill -2000.
5. **Mechatronics System design** by Devadas Shetty and Richard A. Kark – Thomas Learning -1997.
6. **Mechatronics an Introduction** by Robert H Bishop – CRC
- 7 **Mechatronics systems Fundamentals** by Rolf Isermann - Springer

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, V-Semester

#### Departmental Elective ME- 503 (B) Dynamics of Machine

**Unit 1:** Dynamics of Engine Mechanisms: Displacement, velocity and acceleration of piston; turning moment on crankshaft, turning moment diagram; fluctuation of crankshaft speed, analysis of flywheel.

**Unit 2:** Governor Mechanisms: Types of governors, characteristics of centrifugal governors, gravity and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors.

**Unit 3:** Balancing of Inertia Forces and Moments in Machines: Balancing of rotating masses, two plane balancing, determination of balancing masses (graphical and analytical methods), balancing of rotors, balancing of internal combustion engines (single cylinder engines, in-line engines, V-twin engines, radial engines, Lanchester technique of engine balancing.

**Unit 4:** Friction: Frictional torque in pivots and collars by uniform pressure and uniform wear rate criteria. Boundary and fluid film lubrication, friction in journal and thrust bearings, concept of friction circle and axis, rolling friction. Clutches: Single plate and multi plate clutches, Cone clutches.

**Unit 5:** Brakes: Band brake, block brakes, Internal and external shoe brakes, braking of vehicles. Dynamometer: Different types and their applications. Dynamic Analysis of Cams: Response of un-damped cam mechanism (analytical method), follower response analysis by phase-plane method, jump and cross-over shock.

#### References:

1. Ambekar, AG; Mechanism and Machine Theory; PHI
2. Rattan SS; Theory of machines; TMH
3. Sharma and Purohit; Design of Machine elements; PHI
4. Bevan; Theory of Machines;
5. Ghosh and Mallik; Theory of Mechanisms and Machines; Affiliated East-West Press, Delhi
6. Norton RL; kinematics and dynamics of machinery; TMH
7. Grover; Mechanical Vibrations
8. Balaney; Theory of Machines by
9. Theory of Vibrations by Thomson

**List of Experiment (Pl. expand it):**

- 1- Study of various models of governors.
- 2- Study of gyroscopic motion and calculation of value of gyroscopic couple.
- 3- Study of various types of Cams and followers and drawing the cam profile with the help of test kit.
- 4- Study of various first order vibration systems.
- 5- To study working of friction clutches using models

# **RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

## **New Scheme Based On AICTE Flexible Curricula**

### **Mechanical Engineering, V-Semester**

#### **Departmental Elective ME-503 (C) Alternate Automotive Fuels & Emissions**

##### **Unit 1: Introduction Automobile Fuels:**

Classification of Automobile alternative fuels(liquid, gaseous, hydrogen, LPG, CNG, Biogas etc.), Desirable characteristics of SI & CI engine alternative fuels, Rating of SI & CI engine fuels, Introduction to alternate energy sources. Like EV, hybrid, fuel cell and solar cars. merits and demerits of various alternate fuels.

##### **Unit 2: Liquid alternative fuels:**

Vegetable Oils: Various vegetable oils for automobile engines, esterification, performance in engines, performance and emission characteristics, bio diesel and its characteristics. Alcohols: Properties as engine fuel, alcohols and gasoline blends, performance in automobile engine, methanol and gasoline blends.

##### **Unit 3: Gaseous Fuels:**

Biogas: Introduction to Biogas system, Process during gas formation, Factors affecting biogas formation. Usage of Biogas in SI engine & CI engine., Properties of Natural gas, Hydrogen gas, LPG & CNG as engine fuels, storage and handling, performance and safety aspects to all gaseous fuel, fuel metering systems.

##### **Unit 4: Automobile emissions:**

Types of automobile emissions, emission characteristics, formation of automobile emissions, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission CI engine emissions: formation of smoke, factors affecting the smoke formation, unburned hydrocarbons, carbon monoxide, oxides of nitrogen, smog and comparison of diesel and petrol emissions.

##### **Unit 5: Emissions Norms & Measurement:**

Emission norms as per Bharat Standard up to BS – IV and procedures for confirmation on production. Demerits of automobile emission to environment. Types Of Catalytic Conversion, Measurement Techniques Emission Standards and Test Procedure NDIR, FID, Chemiluminescent analyzers, Gas Chromatograph, smoke meters, emission standards.

**References:**

1. J.B. Heywood. Internal combustion Engines, Wiley
2. Ganeshan V; Internal Combustion engines; TMH
3. Mathur M L & Sharma RP; A. Course in IC engines; DhanpatRai
4. R Yadav, Internal Combustion Engines
- 5 Halderman JD and Mitchell CD; Automotive Engines theory and servicing; Pearson
6. DomKundwar; Internal Combustion Engines; Dhanpat Rai Publications
7. Taylor GF; Internal Combustion Engines Theory & Practice; MIT Press
8. Richard Stone; Introduction to IC Engines; Society of Automotive Engr (Palgrave Mc Millan)

**List of Experiment (Pl. expand it):**

1. Study of alternative fuel for automobile.
2. Study of esterification of alternative fuels.
3. Study of blending different types of bio-diesel.
4. Measurement of smoke from automobile.
5. Study of different types of emissions.
6. Study of various techniques for NO<sub>x</sub> reduction.

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, V-Semester

#### Open Elective ME- 504 (A) Industrial Engineering & Ergonomics

**Unit 1 Method study:** purpose of work study, its objectives, procedure and applications; method study definition and basic procedure, selection of job, various recording techniques like outline process charts, flow process charts, man machine charts, two handed process charts, string diagram, flow diagram, multiple activity chart, simo, cyclographs and chrono-cyclographs; critical examination, development, installation and maintenance of improved method; principles of motion economy and their application in work design; micro motion study, memo motion study and their use in methods study.

**Unit 2 Work measurement:** Introduction & definition, objectives and basic procedure of work measurement; application of work measurement in industries; time study: basic procedure, equipments needed, methods of measuring time, selection of jobs, breaking a job into elements; numbers of cycles to be timed; rating and methods of rating, allowances, calculation of standard time.

**Work sampling:** Basic procedure, design of work sampling study conducting work sampling study and establishment of standard-time.

**Unit 3 Job evaluation and incentive schemes:** Starlight line, Taylor, Merrick and Gantt incentive plans

**Standard data system;** elemental and non-elemental predetermined motion systems, work factors system; Methods Time Measurement (MTM), MOST

**Unit 4 Human factor engineering:** Definition and history of development of human factors engineering, types & characteristics of man-machine-system, relative capabilities of human being and machines; development and use of human factor data; information input and processing: Introduction to information theory; factors effecting information reception and processing; coding and selecting of sensory inputs.

**Unit 5 Display systems and anthropometric data:** Display- types of visual display, visual indicators and warning signals; factorial and graphic display; general principles of auditory and tactral display, characteristics and selection.

#### Reference:

1. ILO; work-study; International Labour Organization
2. Khan MI; Industrial Ergonomics; PHI Learning
3. Barrnes RM; Motion and Time Study; Wiley pub
4. Megaw ED; Contentmproy ergonomics; Taylor & francis
5. Sandera M and Mc Cormick E; Human Factors in Engg and design; MGHill
6. Currie RM; Work study; BIM publications
7. Mynard; Hand book of Industrial Engg

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, V-Semester

#### Open Elective ME- 504 (B) TQM and SQC

**Unit 1 Evolution** of total quality management, historical perspective, teamwork, TQM and ISO 9000; information technology and Business Process Re-engineering (BPR); TPM and quality awards; aids and barriers to quality mgt, creating vision and initiating transformation, establishing programs for education and self coordination, policy setting and review, flowchart of policy mgt and relation with daily mgt. improvements, measurement of key indicators; quality mgt leader; cross functional teams and coordination, policy setting and review, flowchart of policy mgt and relation with daily mgt.

**Unit 2 Process-** definition, variation and feedback, funnel-marble experiment- rules of adjustment and its effects, quality- definition, goalpost and kaizen view, quality of design, conformance and performance; Taguchi loss function, cost of quality, chain action of improving quality to productivity to motivation and low cost; Deming's theory of mgt, fourteen points and variance reduction; attributes enumerative and variables analytic studies.

**Unit 3 SQC-Control charts:** basic discrete and continuous distributions, measures of central tendency, variability and shapes, sampling, size and central value theorem, control chart structure, process plotting and stability, study of out-of-control evidences, defect detection and prevention, use of control charts in evaluating past, present and future trends; attribute control charts, count and classification charts, construction and interpretation of  $p$ ,  $np$ ,  $c$  and  $u$  charts, PDSA cycle(plan, do, study, act), and  $R$  charts, and  $s$  charts, individual and moving range chart, trial control limits and out of control points.

**Unit 4 Process diagnostics:** Between and Within Group variations, periodic and persistent disturbances, control chart patterns-natural, level-shift, cycle, wild, multi-universe, relationship and other out of control patterns; diagnosing a process, brainstorming; cause-effect, Ishikava, interrelationship, systematic and matrix diagrams; change concepts and waste elimination

**Unit 5 Process improvement:** Performance and technical specifications, attribute-process and variable-process capability studies; unstable and stable process capability studies and examples; attribute and variable improvement studies; Inspection: acceptance sampling(AS)- lot formation, single, double and multiple/sequential sampling plans, operating characteristic (OC) curve, producer and consumer risk, theoretical invalidation of AS,  $k_p$  rule for stable and chaotic processes.

#### References:

1. Gitlow HS, Oppenheim et al; Quality Management; TMH
2. Gryna FM; Juran's Quality Planning and Analysis; TMH
3. Crosby Philips; Quality is still free; New Amer Library
4. Kulkarni VA and Bewoor AK; Quality Control; Wiley

- 5.** Jankiraman B and Gopal RK; Total Quality Management- Text and Cases; PHI Learning
- 6.** Sugandhi L and Samuel A; Total Quality Management; PHI Learning
- 7.** Subburaj R; Total Quality Management; TMH
- 8.** Naidu Babu and Rajendran; TQM; New age International pub;
- 9.** Chase Richard B et al; Operations management; SIE-TMH
- 10.** Chary SN; Production and Operations Management; TMH



# **RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

## **New Scheme Based On AICTE Flexible Curricula**

### **Mechanical Engineering, V-Semester**

#### **Open Elective ME- 504 (C) Finite Element Method**

##### **Unit-I**

###### **Introduction**

Structural analysis, objectives, static, Dynamic and kinematics analyses, Skeletal and continuum structures, Modeling of infinite d.o.f. system into finite d.o.f. system, Basic steps in finite element problem formulation, General applicability of the method.

##### **Unit-II**

###### **Element Types and Characteristics**

Discretization of the domain, Basic element shapes, Aspect ratio, Shape functions, Generalized co-ordinates and nodal shape functions. 1D spar and beam elements, 2D rectangular and triangular elements, Axisymmetric elements.

##### **Unit-III**

###### **Assembly of Elements and Matrices**

Concept of element assembly, Global and local co-ordinate systems, Band width and its effects, Banded and skyline assembly, Boundary conditions, Solution of simultaneous equations, Gaussian elimination and Cholesky decomposition methods, Numerical integration, One and 2D applications.

##### **Unit-IV**

###### **Higher Order and Isoparametric Elements**

One dimensional quadratic and cubic elements, Use of natural co-ordinate system, Area co-ordinate system continuity and convergence requirements, 2D rectangular and triangular requirement.

##### **Unit-V**

###### **Static & Dynamic Analysis**

Analysis of trusses and frames, Analysis of machine subassemblies, Use commercial software packages, Advantages and limitations  
Hamilton's principle, Derivation of equilibrium, Consistent and lumped mass matrices, Derivation of mass matrices for 1D elements, Determination of natural frequencies and mode shapes, Use of commercial software packages.

**References:**

- Rao, S.S., The Finite Element Method in Engineering, 2<sup>nd</sup> ed., Peragamon Press, Oxford.
- Robert, D. Cook., David, S. Malkins, and Michael E. Plesha, Concepts and Application of Finite Element Analysis 3<sup>rd</sup> ed., John Wiley.
- Chandrupatla, T.R. an Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India Pvt. Ltd.
- Zienkiewicz O C, The Finite Element Method, 3<sup>rd</sup> ed, Tata McGraw Hill.

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, V-Semester**

**ME505- FEM/CFD Lab**

**List of Experiments (Please Expand it)**

1. To study fundamentals of Computational Fluid Dynamics (CFD)
2. To perform CFD analysis of lid driven cavity in Open-Foam
3. To perform CFD analysis of square tube in Open-Foam
4. To perform CFD analysis of a 2D-plate in Open-Foam
5. To perform CFD analysis of bifurcated blood vessel in FEM
6. To study fundamentals of Finite element method and FEA
7. To perform FEM analysis of deep drawing process in FEM
8. To study fundamentals of Sci-Lab
9. To perform matrix operations in Sci-lab
10. To plot 2D & 3D graphs in Sci-lab

**References:**

1. Versteeg H; An introduction to Computational Fluid Dynamics (The Finite Volume Method);Pearson
2. Jiyuan Tu; Computational Fluid Dynamics: A Practical Approach; Butterworth-Heinemann.
3. Gokhale NS; Practical Finite Element Analysis; Finite to Infinite
4. Seshu P; Finite element analysis; PHI.
5. Reddy JN; Introduction to the Finite Element Method;McGraw Hill Inc.
6. Das VV; Programming in Scilab 4.1; New Age International Publishers.
7. Verma A K; Scilab : A Beginner's Approach; Cengage publishers.

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, V-Semester**

**ME506- Python**

**List of Experiments (Please Expand it):**

1. To write a Python program to find GCD of two numbers.
2. To write a Python Program to find the square root of a number by Newton's Method.
3. To write a Python program to find the exponentiation of a number.
4. To write a Python Program to find the maximum from a list of numbers.
5. To write a Python Program to perform Linear Search
6. To write a Python Program to perform binary search.
7. To write a Python Program to perform selection sort.
8. To write a Python Program to perform insertion sort.
9. To write a Python Program to perform Merge sort.
10. To write a Python program to find first n prime numbers.
11. To write a Python program to multiply matrices.
12. To write a Python program for command line arguments.
13. To write a Python program to find the most frequent words in a text read from a file.
14. To write a Python program to simulate elliptical orbits in Pygame.
15. To write a Python program to bouncing ball in Pygame.

**References:**

1. Timothy A. Budd: Exploring python, McGraw-Hill Education.
2. R.Nageshwar Rao , "Python Programming" , Wiley India
3. Allen B. Downey; Think Python, O'Reilly Media, Inc.

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, VII-Semester

#### ME- 701 Heat and Mass Transfer

##### Course Objectives:

After studying this course, students will be able to

1. Know about the basic concept of heat transfer and its modes.
2. Solve problems based on conduction, convection, and radiation.
3. Differentiate the modes of heat transfer i.e. conduction, convection, and radiation
4. Understand the working principle and types of heat exchangers.
5. Understand the concept of boiling and condensation, mass transfer.

##### Syllabus:

**Unit-1 Basic Concepts:** Modes of heat transfer, Fourier's law, Newton's law, Stefan Boltzman law; thermal resistance and conductance, analogy between flow of heat and electricity, combined heat transfer process; Conduction: Fourier heat conduction equation, its form in rectangular, cylindrical and spherical coordinates, thermal diffusivity, linear one dimensional steady state conduction through a slab, tubes, spherical shells and composite structures, electrical analogies, critical-insulation-thickness for pipes, effect of variable thermal conductivity.

**Unit 2 Extended Surfaces (fins):** Heat transfer from a straight and annular fin (plate) for a uniform cross section; error in measurement of temperature in a thermometer well, fin efficiency, fin effectiveness, applications; Unsteady heat conduction: Transient and periodic conduction, heating and cooling of bodies with known temperatures distribution, systems with infinite thermal conductivity, response of thermocouples.

**Unit 3 Convection:** Introduction, free and forced convection; principle of dimensional analysis, Buckingham 'pie' theorem, application of dimensional analysis of free and forced convection, empirical correlations for laminar and turbulent flow over flat plate and tubular geometry; calculation of convective heat transfer coefficient using data book.

**Unit 4 Heat Exchangers:** Types- parallel flow, counter flow; evaporator and condensers, overall heat transfers coefficient, fouling factors, log-mean temperature difference (LMTD), method of heat exchanger analysis, effectiveness of heat exchanger, NTU method;

**Mass transfer:** Fick's law, equi-molar diffusion, diffusion coefficient, analogy with heat transfer, diffusion of vapour in a stationary medium.

**Unit 5 Thermal Radiation :** Nature of radiation, emissive power, absorption, transmission, reflection and emission of radiation, Planck's distribution law, radiation from real surfaces; radiation heat exchange between black and gray surfaces, shape factor, analogical electrical network, radiation shields.

**Boiling and condensation:** Film wise and drop wise condensation; Nusselt theory for film wise condensation on a vertical plate and its modification for horizontal tubes; boiling heat transfer phenomenon, regimes of boiling, boiling correlations.

**References:**

1. Sukhatme SP; Heat and mass transfer; University Press Hyderabad
2. Holman JP; Heat transfer; TMH
3. Nag PK; heat and Mass Transfer; TMH
4. Domkundwar, Heat and Mass Transfer, Dhanpt Rai & Co.
5. Sachdeva R.C., Fundamentals of Engineering Heat and Mass Transfer, New Age Science
6. Dutta BK; Heat Transfer Principles And App; PHI Learning
7. Mills AF and Ganesan V; Heat transfer; Pearson
8. Cengel Yunus A; Heat and Mass transfer; TMH
9. Yadav R; Heat and Mass Transfer; Central India pub-Allahabad
10. Incropera FP and Dewitt DP; Heat and Mass transfer; Wiley

**List of Experiments (Pl. expand it):**

- 1 Conduction through a rod to determine thermal conductivity of material
- 2 Forced and free convection over circular cylinder
- 3 Free convection from extended surfaces
4. Parallel flow and counter flow heat exchanger effectiveness and heat transfer rate
5. Calibration of thermocouple
- 6 . Experimental determination of Stefan-Boltzmann constant

**Evaluation**

Evaluation will be continuous an integral part of the class as well through external assessment.

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, VII-Semester**

**Departmental Elective ME- 702(A) Advance Machining Processes**

**Course Objectives:**

- Understand the fundamentals and technologies used in different advance machining processes.
- Apply the characteristics and applications of the product obtained using advanced manufacturing processes.
- Compare different advance machining processes.

**Syllabus:**

**Unit 1: Mechanical processes;** Process selection, mechanics of cutting, metal removal rate, cutting tool system design, ultrasonic machining, abrasive jet machining, water jet machining, , effect of parameters and variables, applications and limitations, recent developments in mechanical processes.

**Unit 2: Electrochemical and chemical metal removal processes;** Electrochemical machining[ECM], elements of ECM, power source and control system, electrolytes, tool work system, chemistry of the process, tool design and metal removal rate, process faults, material removal and surface finish, electrochemical grinding, electrochemical deburring, electrochemical honing, chemical machining,

**Unit 3: Thermal metal removal processes;** Electric discharge machining[EDM], spark erosion, mechanism of metal removal, spark erosion generator, electrode feed control, vibrating electrode system, dielectric fluid, flushing, accuracy, plasma arc machining[PAM], non thermal generation of plasma, mechanisms and parameters, equipments, electron beam machining[EBM], generation and control of electron beam, theory and process capabilities, neutral particle etching, laser beam machining, hot machining, methods of local heating, tool life and production rate.

**Unit 4: Rapid prototyping fabrication methods;** Fundamentals, technologies, applications, principles and working of 3D printing, subtractive v/s additive manufacturing process, VAT photo polymerization, material and binder jetting, continuous liquid inter phase production, direct metal laser sintering.

**Unit 5: Technologies of micro fabrication;** Types of micro system devices, industrial applications, micro fabrication processes, LIGA process .Technologies of nano fabrication, importance of size, scanning probe microscope, carbon Buckyballs and nano tubes, nano fabrication processes,

**References:**

1. Mikell P. Groover, Fundamentals of Modern Manufacturing, Wiley India, ISBN 978 81 265 2301 6
2. Pandey P.C, Shan H.S., Modern Machining Processes, Tata McGraw Hill, ISBN 0 07 096518 8
3. Lal G.K, Gupta V, Reddy N.V., Narosa Publishing House, ISBN 81 7319 709 1
4. CMTI Handbook
5. Jain V.K. Introduction to Micro Machining Process Narosa Publication
6. Jain V.K. ,Micromanufacturing Processes , Crc Press.

**Evaluation**

Evaluation will be continuous an integral part of the class as well through external assessment.

# **RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

## **New Scheme Based On AICTE Flexible Curricula**

### **Mechanical Engineering, VII-Semester**

#### **Departmental Elective ME- 702(B) Internet of Things**

##### **Course Objectives :**

The explosive growth of the "Internet of Things" is changing our world and the rapid drop in price for typical IoT components is allowing people to innovate new designs and products at home. The Internet of Things (IoT) is a course about the new paradigm of objects interacting with people, with information systems, and with other objects. The course will focus on creative thinking and on hands-on project development.

After learning the course, the student will be able:

1. Understand the vision of IoT from a global context.
2. Understand the application of IoT.
3. Determine the Market perspective of IoT.
4. Use of Devices, Gateways and Data Management in IoT.
5. Building state of the art architecture in IoT.
6. Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

##### **Unit I: Internet of Things (IoT)**

Vision, Definition, Conceptual Framework, Architectural view, technology behind IoT, Sources of the IoT, M2M Communication, IoT Examples . Design Principles for Connected Devices: IoT/M2M systems layers and design standardization, communication technologies, data enrichment and consolidation, ease of designing and affordability .

##### **Unit II: Hardware for IoT**

Sensors, digital sensors, actuators, radio frequency identification (RFID) technology, wireless sensor networks, participatory sensing technology. Embedded Platforms for IoT: Embedded computing basics, Overview of IOT supported Hardware platforms such as Arduino, Raspberry pi, Beagle Bone, Intel Galileo .

##### **Unit III: IoT PROTOCOLS**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks, Zigbee – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT .

##### **Unit IV: Security**

Understanding the risks, Modes of attack - Denial of Service Guessing the credentials , Getting access to stored credentials, Man in the middle , Sniffing network communication , Port scanning and web crawling ,Search features and wildcards ,Breaking ciphers , Tools for achieving security - Virtual Private Networks , X.509 certificates and encryption , Authentication of identities , Usernames and passwords , Using message brokers and provisioning servers ,Centralization versus decentralization .



**Unit V: IoT Applications**

Home Automation- Smart Appliances , Smoke/ Gas Detection, Cities – Smart Parking ,Smart Lighting , Smart Road , Health and Lifestyle- Health and fitness monitoring, Retail- Smart Payments. Case Studies: Smart city streetlights:- control and monitoring

**References:**

- 1.Raj Kamal "Internet of Things", McGraw-Hill, 1st Edition, 2016
- 2.Olivier Hersent,David Boswarthick, Omar Elloumi "The Internet of Things key applications and protocols", Wiley
3. Peter Waher, "Learning Internet of Things", Packt publishing
- 4.Arshdeep Bahga, Vijay Madisetti, "Internet of Things ( A hands on approach)" University Press (India)
- 5.Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications, 2013
- .6. Cuno Pfister, Getting Started with the Internet of Things, O'Reilly Media, 2011, ISBN: 978-1-4493-9357-1

**Evaluation** Evaluation will be continuous an integral part of the class as well through external assessment

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, VII-Semester

#### Departmental Elective ME- 702(C) Power Plant Engineering

##### Course Objectives:

After studying this course, students will be able to

1. Understand the conversion of renewable energy system into electrical power.
2. Design & enhance the performance of fossil fuel based power plant.
3. Analyze the nuclear power plant and its safety.
4. Design & enhance the performance of hydro based power plant.
5. Determine economics of the power plant of renewable and non renewable / nuclear power system

##### Syllabus:

##### Unit I: Introduction:

Introduction to methods of converting various energy sources to electric power, direct conversion methods renewable energy sources, solar, wind, tidal, geothermal, bio-thermal, biogas and hybrid energy systems, fuel cells, thermoelectric modules, MHD-Converter

##### Unit II: Fossil fuel steam stations:

Basic principles of siting and station design, effect of climatic factors on station and equipment design, choice of steam cycle and main equipment, recent trends in turbine and boiler sizes and steam conditions, plant design and layout, outdoor and indoor plant, system components, fuel handling, burning systems, element of feed water treatment plant, condensing plant and circulating water systems, cooling towers, turbine room and auxiliary plant equipment., instrumentation, testing and plant heat balance.

##### Unit III: Nuclear Power Station:

Importance of nuclear power development in the world and Indian context, Review of atomic structure and radio activity, binding energy concept, fission and fusion reaction, fissionable and fertile materials, thermal neutron fission, important nuclear fuels, moderators and coolants, their relative merits, thermal and fast breeder reactors, principles of reactor control, safety and reliability features.

##### Unit IV: Hydro-Power Station:

Elements of Hydrological computations, rainfall run off, flow and power duration curves, mass curves, storage capacity, salient features of various types of hydro stations, component such as dams, spillways, intake systems, head works, pressure tunnels, penstocks, reservoir, balancing reservoirs, Micro and pico hydro machines, selection of hydraulic turbines for power stations, selection of site.

##### Unit V: Power Station Economics:

Estimation and prediction of load. Maximum demand, load factor, diversity factor, plant factor and their influence on plant design, operation and economics; comparison of hydro and nuclear power plants typical cost structures, simple problems on cost analysis, economic performance and tariffs, interconnected system and their advantages, elements of load dispatch in interconnected systems.

**References:**

- 1- Nag PK; Power plant Engg; TMH
- 2- Al-Wakil MM; Power plant Technology; TMH
- 3- Sharma PC; Power plant Engg; Kataria and sons, Delhi
- 4- Domkundwar; Power Plant Engg; Dhanpatrai & sons.
- 5- Rajput RK; A text book of Power plant Engg.; Laxmi Publications.

**Evaluation**

Evaluation will be continuous an integral part of the class as well through external assessment.

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, VII-Semester**

**Departmental Elective ME- 702(D) Advance Machine Design**

**Course Objective**

- Understand the design concepts of belt, rope and chain drives.
- Able to design different types of gears.
- Able to design I.C. Engine components, different types of couplings and power screw
- Inspect miscellaneous components such as flanged coupling, rigid coupling, and pressure vessels.

**Course Contents:**

**Unit- I: Design of Belt, Rope and Chain Drives:** Methods of power transmission, design of flat belt drive and V-belt drive ; Design of chain drives, roller chain and its selection; Design of rope drives.

**Unit- II: Spur and Helical Gears:** Force analysis of gear tooth, AGMA Bending stress equation and AGMA Contact stress equation, modes of failure, beam strength, Lewis equation, form factor, formative gear and virtual number of teeth; Gear materials; Surface strength and wear of teeth; strength against wear; Design of straight tooth spur and Helical Gears.

**Unit- III: Bevel Gears:** Application of bevel, formative gear and virtual number of teeth; Force analysis; Lewis equation for bevel gears; Strength against wear; Design of bevel gear.

**Unit- IV: Design of I.C. Engine Components:** General design considerations in I C engines; design of cylinder; design of piston and piston-rings; design of connecting rod; design of crankshaft.

**Unit -V: Design of Miscellaneous Components:** Design of Knuckle joint, Design of Cotter joint, Design of keys, Design of Flanged coupling; Rigid coupling and Flexible coupling ,Design of Pressure vessels subjected to internal pressure, Design of power screw.

**References:**

1. Shigley J.E.; Machine Design; TMH
2. Bhandari VB; Design of Machine Elements; TMH
3. Abdul Mubeen; Machine Design; Khanna Publishers
4. Sharma & Agrawal; Machine Design; Katson
4. Sharma CS and Purohit K; Design of Machine Elements; PHI Learning.
5. Dwivedi and Pandey; Machine Drawing and Design, Dhanpat Rai & Co.
6. Wentzell TH; Machine Design; Cengage Learning
7. Hall and Somani; Machine Design; Schaum Series; TMH
8. Kulkarni SG; Machine Design; TMH
9. Norton R; Design Of Machinery; TMH

**Note: PSG Design data book and/ or Mahadevan and Reddy's Mechanical design data book are to be provided/ permitted in exam hall (duly verified by authority)**

**Evaluation:** Evaluation will be continuous an integral part of the class as well through external assessment

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, VII-Semester**

**Open Elective ME- 703(A) Operation Research & Supply Chain**

**Course Objective:**

The student will be made .

1. To be familiar with all the OR Techniques and optimization methods.
2. To understand the role of logistics in the supply chain within a focal firm as well as between organisations linked within a given supply chain network. and ,
3. To be familiar with various inventory control techniques.
4. To clear idea of the decision making and meta-heuristic algorithm.

**Course Content:**

**Unit I Linear system and distribution models:** Mathematical formulation of linear systems by LP, solution of LP for two variables, Simplex method, special cases of LP- transportation and assignment model and their graphical solution, Vogels Approximation Method (VAM) or penalty method, cell evaluation degeneracy, basics of SW Lindo, Tora, Excell.

**Unit II Supply chain (SCM):** Definition, importance, expenditure and opportunities in SCM; integration of inbound, outbound logistics and manufacturing to SCM, flow of material money and information, difficulties in SCM due to local v/s system wide (global) optimization and uncertainties in demand and transportation; Bull-whip effect; customer value; IT, info-sharing and strategic partnerships; plant and warehouse-network configuration; supply contracts and revenue sharing; outsourcing; transportation, cross docking and distribution, forecasting models in SCM; coordination and leadership issues; change of purchasing role and vendor rating, variability from multiple suppliers.

**Unit III Inventory models:** Necessity of inventory in process and safety stock, problem of excess inventory and cycle time, JIT/ Lean Mfg; basics of inventory models with deterministic demand, Classical EOQ Model, ABC, VED and other analysis based on shelf life, movement, size, MRP technique and calculations, lot sizing in MRP, linking MRP with JIT; evolution of MRP to ERP to SCM and e-business.

**Unit IV (a) Waiting Line Models:** Introduction, Input process, service mechanism, Queue discipline,

single server (M/M/1), average length and average time calculations, optimum service rate; basic multiple server models (M/M/s)

(b) **Competitive strategy:** concept and terminology, assumptions, pure and mixed strategies, two-person zero sum games, saddle point, dominance, graphical, algebraic and LP methods for solving game theory problems.

**Unit V: (a) Network Analysis:** Project Planning, Scheduling and Controlling; Project management; Network Techniques and its role in project management, Network logics, Fulkerson's Law, Merits and Demerits of AON Diagrams; Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Determination of critical path, Float/Slack.

(b) **Meta-heuristics:** Definition of heuristic and meta-heuristic algorithms; introduction to Tabu search, Simulated Annealing and Genetic algorithms and solution of traveling salesman, non linear optimization problems.

**References:**

1. Hillier FS and Liberman GJ; Introduction to Operations Research concept and cases; TMH
2. Simchi-Levi, Keminsky; Designing and managing the supply chain; TMH.
3. Heera and Gupta, Operation Research, S Chand Pub.
4. Sharma JK; Operations Research; Macmillan
5. Taha H; Operations research; PHI
6. Jain, pandey & shrivastava; Quantitative techniques for management, New Age publishers.
7. Srinivasan G; Quantitative Models In Operations and SCM; PHI Learning
8. Mohanty RP and deshमुख SG; Supply Chain Management; Wiley India
9. Sen RP; Operations Research-Algorithms and Applications; PHI Learning
10. Bowersox DJ, Closs DJ, Cooper MB; Supply Chain LogistiMgt; TMH
11. Bronson R ;Theory and problems of OR; Schaum Series; TMH
12. Kantiswaroop, Operation Research, Sultan Chand

**Course Out Comes:****Evaluation:**

Evaluation will be continuous and integral part of the class as well as through external assessment.

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, VII-Semester

#### Open Elective ME- 703(B) Artificial Intelligence Techniques

##### Course Objectives

##### After studying this course, students will be able to

1. learn about importance of AI techniques. Adoption of Artificial Intelligence (AI) technologies is widely expanding in our society. Applications of AI include: self-driving cars, personal assistants, surveillance systems, robotic manufacturing, machine translation, financial services, cyber security, web search, video games, code analysis and product recommendations.
2. Know the exact application of AI Techniques. Such applications use AI techniques to interpret information from a wide variety of sources and use it to enable intelligent, goal-directed behavior.
3. understand the working of Modern AI based systems. It often involves self-learning systems that are trained on massive amounts of data, and/or interacting intelligent agents that perform distributed reasoning and computation.
4. Know about sensors used in AI based systems. AI connects sensors with algorithms and human-computer interfaces, and extends itself into large networks of smart devices.
5. know the opportunities after having knowledge of AI techniques. The knowledge of Artificial Intelligence opens career opportunities in companies that are building the next generation of intelligence and language understanding for their products: for example intelligent personal assistants, opinion mining systems, customer support system, biomedical applications, computer games, smart adaptive devices, robots, smart planning systems.

##### Syllabus

##### Unit 1: Introduction to Artificial Intelligence

Main components and characteristics of AI (Feature Engineering, ANN, Deep Learning), Applications of AI, Advantages and disadvantages of AI, Goals of AI, Comparison of Programming of a System with AI and without AI, Challenges in AI, Programming languages preferably used in AI, Techniques/Algorithms used in AI, AI Software platforms, Future of AI

**Unit 2: Various types of production systems and search techniques:** Types of production systems, Characteristics of production systems, Study and comparison of breadth first search and depth first search. Techniques, other Search Techniques like hill Climbing, Best first Search. A\* algorithm, AO\* algorithms etc, and various types of control strategies.

**Unit 3: Knowledge Representation and Probabilistic Reasoning:** Problems in representing knowledge, knowledge representation using propositional and predicate logic, comparison of propositional and predicate logic, Resolution, refutation, deduction, theorem proving, inferencing, monotonic and nonmonotonic reasoning. Probabilistic reasoning, Baye's theorem, semantic networks, scripts, schemas, frames, conceptual dependency, fuzzy logic, forward and backward reasoning.

**Unit 4: Game playing techniques:** Minimax procedure, alpha-beta cut-offs etc, planning, Study of the block world problem in robotics, Introduction to understanding and natural languages processing.

**Unit 5: Introduction to learning ,ANN:** Various techniques used in learning, introduction to Artificial neural networks, common sense, reasoning, Convolution Neural Network, Feedforward Neural Network, Recurrent Neural Network, Multilayer perceptron, Architecture / Three Layers in Artificial Neural Networks, Implementation of ANN, Applications of ANN in images, signals and languagesome example of expert systems.

**References:-**

1. Rich E and Knight K, "Artificial Intelligence", TMH, New Delhi.
2. Nilsson N.J., "Principles of Artificial Intelligence", Springer Verlag, Berlin.
3. Stuart Russell , Artificial Intelligence: A Modern Approach , 3rd Edition), Peter Norvig, PHI, ISBN-13: 978-0136042594, ISBN-10: 0136042597
4. B. Yegnanarayana , Artificial Neural Networks , PHI
5. Schalkoff, Artificial Neural Networks . Mc Graw HILL Education

**Evaluation:**

Evaluation will be continuous and integral part of the class as well as through external assessment



# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, VII-Semester

#### Open Elective ME-703(C) Systems Engineering

This course in systems engineering examines the principles and process of creating effective systems to meet application demands.

The course is organized as a progression through the systems engineering processes of analysis, design, implementation, and deployment with consideration of verification and validation throughout.

COURSE OUTCOME: After successful completion of the course, students would be able to

- \* Plan and manage the systems engineering process
- \* Examine systems from many perspectives (such as software, hardware, product, etc.)
- \* Distinguish critical functions, diagnose problems, and apply descoping strategies and judge the complexity of production and deployment issues.
- \* Know about the complexity in modern systems such as in missiles, rocket engines, modern automobiles etc.
- \* Solve real complex problems

#### **Syllabus:**

##### **Unit 1: Overview of Systems Engineering:**

Introduction, Origin, Examples of Systems requiring systems engineering, Systems Engineer Career Development Model, Perspectives of Systems Engineering, Systems Domains, Systems Engineering Fields, System Engineering Approaches.

##### **Unit 2: Structure of Complex Systems:**

System Building Blocks and Interfaces, Hierarchy of Complex Systems, System Building Blocks, The System Environment, Interfaces and Interactions, Complexity in Modern Systems.

##### **Unit 3 Concept Development and Exploration:**

Originating a New System, Operational Analysis, Functional Analysis, Feasibility, System Operational Requirements, Implementation of Concept Exploration. Exploration in system life cycle, Concept definition phase, Activities involved in concept definition phase.

##### **Unit 4: Engineering Development:**

Reducing Program Risks, Requirements Analysis, Functional Analysis and Design, Prototype Development as a Risk Mitigation Technique, Development Testing, Risk Reduction. Place of engineering design phase in system life cycle, Various activities involved in engineering design phase.

##### **Unit 5: Integration and Evaluation:**

Integrating, Testing, And Evaluating The Total System, Test Planning And Preparation, System Integration, Developmental System Testing, Operational Test And Evaluation, Engineering For Production, Transition From Development To Production, Production Operations. operation and support phase.

**Books:**

1. Alexander Kossiakoff, William N Sweet, "System Engineering Principles and Practice, Wiley India
2. Blanchard Fabrycky, Systems engineering and analysis, Pearson
3. Dwivedi Krishna K, Pandey M., Fundamentals of Systems Engineering , Wiley Precise Text book Series, Wiley India. ISBN: 978-265-6654-9
4. Dennis M. Buede, William D. Miller, "The Engineering Design of Systems: Models & Methods" Wiley India
5. Jeffrey L Whitten, Lonnie D Bentley, "System Analysis and Design Methods" 6. Richard Stevens, Peter Brook, " System Engineering – Coping with complexity, Prentice Hall of India.
7. Eisner, H. Essentials of Projects and Systems Engineering Management, 2nd edition. John Wiley & Sons, New Jersey, USA.
8. Buede, D. M.. The Engineering Design of Systems, Models and Methods. John Wiley & Sons, New Jersey, USA.

**Evaluation:**

Evaluation will be continuous and integral part of the class as well as through external assessment

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, VII-Semester

#### Open Elective ME-703(D) Reliability Engineering

Course Objectives:

1. To introduce the basic concepts of reliability, various models of reliability.
2. To analyze reliability of various systems.
3. To introduce techniques of frequency and duration for reliability evaluation of repairable systems.

#### **Unit 1. Reliability :**

Definition, Importance, History, Reliability Vs. Quality, Failure pattern of complex product, Factor of safety and reliability, Reliability analysis procedure, Reliability management, Some examples of system failures., Reliability function-MTTF, Hazard rate function, Bath tub curve

#### **Unit 2. Basic probability theory:**

Set theory, Laws of probability, Probability theorem Random variables and probability distributions, Bay's Theorem, Central limit theorem,

#### **Unit 3. Functions of random variables:**

Single, two and several random variables, Probability distribution functions, density functions for different types of discrete and continuous variables, mean, mode and median, Numerical solutions, Extremal distributions, derivation of the reliability function-constant failure rate model – time dependent failure models. Weibull distribution – normal distribution – the lognormal distribution.

#### **Unit 4. Modeling of geometry, strength and loads:**

Fatigue strength, Time dependent reliability of components, Failure rate versus time, reliability and hazard functions and different distributions, Estimation of failure rate, Expected residual life, Series, parallel and mixed systems, complex systems, Reliability enhancement,

#### **Unit 5. Reliability based design:**

Optimization problems, Failure modes and effect analysis, Event tree and fault tree analysis, Reliability testing, Reliability data and analysis, measurement of reliability, Monte Carlo Simulation, Computation of reliability, Optimization techniques for system reliability with redundancy – heuristic methods applied to optimal system reliability- redundancy allocation by dynamic programming – reliability optimization by non linear programming.

#### **References:**

1. Singiresu S. Rao, Reliability Engineering, Pearson
2. Grant E. L. & Leavell Worth, Statistical Q. C., T.M.H.
3. Balagurusamy, Reliability Engg., T.M.H.
4. Mahajan, Statistical Q.C.
5. Juran and Grayan, Quality Planning Analysis, T.M.H
6. Charles E. Ebling, "An introduction to Reliability and Maintainability Engg", Tata McGraw-Hill, 2000
7. Atrick D T o'connor, "Practical Reliability Engineering", John-Wiley and Sons inc, 2002
8. David J Smith, "Reliability, Maintainability and Risk: Practical Methods for Engineers", Butterworth, 2002.

9. Srinath I.S, Engineering Design and Reliability, ISTE, 1999.

**Evaluation:**

Evaluation will be continuous and integral part of the class as well as through external assessment

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, VII-Semester**

**ME- 704 CAD/CAM /CIM**

The purpose of this laboratory is to provide the complete practical exposure of Computer aided design software tools such as Solid works, CATIA, Unigraphics etc., Computer assisted manufacturing processes such as CNC Turning, CNC Milling, CNC Drilling etc as well Computer integrated manufacturing (i.e. demonstrating remotely over the internet the operations of actual CIM cell established in the dept of Institute /industry) to the students so that they will become industry ready just after completing their graduation.

Suggested list Experiments; (PI expand it)

1. 2D and 3D modeling on CAD software
2. Use of CAM software for writing CNC programs
3. Study of automatic and semi automatic control system and writing the electrical analogy.
4. Production & layout for GT for group of jobs to be manufactured
5. A case study / tutorial using CAPP Software
6. Writing M & G codes for given operations.
7. Robot and AGV programming
8. Modelling and simulation of computer integrated manufacturing system'
9. Modelling, offline manual part programming and simulation of the operation of 3 axis CNC milling machine
10. Programming and operation of a 5 axis robot Manipulator
11. Remote monitoring and operation of Computer integrated manufacturing system
12. To write the part program for any component (stepped cylindrical rod ) . Assuming the work piece is Aluminum and the speed is 1200 rpm, feed 20 mm/min and maximum depth of cut is 1 mm.
  - a. With Canned cycle
  - b. Without Canned cycle.

**Evaluation:**

Evaluation will be continuous and integral part of the class as well as through external assessment (Viva/voce)

# RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

## New Scheme Based On AICTE Flexible Curricula

### Mechanical Engineering, VII-Semester

#### ME- 705 MATLAB and R Programming

The purpose of this laboratory is to provide the knowledge of latest research tools/techniques such as MATLAB and R Programming which is being used in finding out the solution of most of the engineering problems. **MATLAB** is a multi-paradigm numerical computing environment and proprietary programming language developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

Following are the suggested list of experiments related to MATLAB (PI expand)

1. Introduction to MATLAB
2. Working with matrices
3. Rational and logical operation of MATLAB
4. Creating a plot using Plot function
5. Complex and stastical functions (e.g.: Produce ten elements vector of random complex numbers and find the summation of this vector)
6. Numbers and strings (1. Write a program in M-File to read 3 x 3 Matrix, then display the diagonal of matrix as shown below: The Diagonal of This Matrix = [ ]  
2. Write a program to read a string, then replace each character in the string with its following character in ASCII code\*.)

**R Programming** is a programming language and free software environment for statistical computing and graphics supported by the **R** Foundation for Statistical Computing. The **R** language is widely used among statisticians and data miners for developing statistical software and data analysis.

In this lab, students are supposed to learn how to program in R and how to use R for effective data analysis. Students need to learn how to install and configure software necessary for a statistical programming environment and describe generic programming language concepts as they are implemented in a high-level statistical language.

The lab should cover practical issues in statistical computing which includes programming in R, reading data into R, accessing R packages, writing R functions, debugging, profiling R code, and organizing and commenting R code.

Following are the suggested tutorials to be covered:

1. What is R Programming Language?
2. How to Download & Install R, RStudio, Anaconda on Mac or Windows
3. Weite R Data Types, Arithmetic & Logical Operators with Example
4. Write about R Matrix : Create, Print, add Column, Slice
5. Explain Factor in R: Categorical & Continuous Variables
6. Explain about R Data Frame: Create, Append, Select, Subset.

#### Evaluation:

Evaluation will be continuous and integral part of the class as well as through external assessment (Viva/voce)

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL**

**New Scheme Based On AICTE Flexible Curricula**

**Mechanical Engineering, VII-Semester**

**ME- 706 Major Project -I**

**Objectives of the course Major Project I :**

- To provide students with a comprehensive experience for applying the knowledge gained so far by studying various courses.
- To develop an inquiring aptitude and build confidence among students by working on solutions of small industrial problems.
- To give students an opportunity to do some thing creative and to assimilate real life work situation in institution.
- To adapt students for latest development and to handle independently new situations.
- To develop good expressions power and presentation abilities in students. The focus of the Major Project I is on preparing a working system or some design or understanding of a complex system using system analysis tools and submit it the same in the form of a write up i.e. detail project report.

The student should select some real life problems for their project and maintain proper documentation of different stages of project such as need analysis market analysis, concept evaluation, requirement specification, objectives, work plan, analysis, design, implementation and test plan. Each student is required to prepare a project report and present the same at the final examination with a demonstration of the working system (if any)

**Working schedule:**

The faculty and students should work according to following schedule:

Each student undertakes substantial and individual project in an approved area of the subject and supervised by a faculty of the department. In special case, if project is huge, then maximum 03 students may be permitted to work together as a team to do the same. The student must submit outline and action plan for the project execution (time schedule) and the same be approved by the concerned faculty and Head of department.

Project guide should motivate students to develop some Innovative working models in the area of Advanced Automotives, Aero modelling, Renewable Energy based systems, Mechatronics, Robotic systems, Advanced Manufacturing Technology based systems etc. which can contribute to the society.

**Evaluation:**

There will be both external and internal evaluation of project carried out by each student.