Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Branch- Common to All Discipline

New Scheme Based On AICTE Flexible Curricula

BT301	**Mathematics-III**	**3L-1T-0P**	**4 Credits**

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 predicator-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

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

Electric Vehicles, III Semester

EV 302 - Kinematics of Machines

Objectives : To familiarize the students with the fundamentals of theory of machines.

Learning Outcomes : At the completion of this course, students will be able to

1. know the concepts of kinematic links, pair, inversion and mechanism.
2. analyse simple and compound mechanism
3. understand concept of kinematics of CAM mechanism
4. have knowledge about different types of power transmission systems
5. design and develop different types of gears

UNIT 1: Simple Mechanism: Introduction, kinematics and kinetics, , concept of kinematic links, basic terminology and definitions, types of motion, kinematic joint, kinematic pair, mechanisms and machines, degree of freedom, Mobility - Kutzbach criterion (Gruebler's equation) - Grashoff's law, kinematic chains, inversions of four bar chain mechanism, single slider crank mechanism, double sliders crank mechanism

UNIT 2 : Kinematic Analysis of Simple Mechanism: Velocity analysis of simple mechanisms, Graphical method, Velocity and acceleration polygons , Velocity analysis using instantaneous centres, Kennedy Theorem, relative velocity method, Acceleration Analysis, Coincident points, Coriolis component of Acceleration.

Unit 3 Kinematics of CAM Mechanisms : Introduction, classifications of Cams and followers, nomenclature, analysis of cam and follower motion: Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions, construction of cam profile.

Unit 4 : Power Transmission Systems: : Kinematics of belt- pulley, flat and v –belt drive, rope drive , Relation between tension ratio for flat belt drive and rope drive, power transmission through belt and rope drives, centrifugal tension, initial tension in belt. condition of maximum power transmission for belt drive.

Clutches and Brakes: Purpose of Clutch, classifications, Single and multi plate clutch, cone clutch, brakes, classifications, single and double block, band, internal and external.

Unit 5: Gears and Gear Trains: Basic terminology, Classification of toothed gearing, Law of gearing, tooth profiles, types of gears, spur, bevel, worm, helical, hypoid ,interference in involute gears, Gear trains, Types: Simple and Compound gear train, Reverted gear train, Epicyclic , Sun and Planet type.

Text Books:

1. Theory of Machines by S.S Ratan, THH

2. Theory of Machines by V.P Singh; Dhanpat Rai and sons, New Delhi.

3. Theory of Machines by Jagdish Lal; Metropolitan Publishers, New Delhi.

4. Theory of Machine by R.S.Khurmi,

S. Chand 5. Theory of Machine by R.K.Bansal, ,Laxmi Publication.

Reference Books:

1. E-books/e-tools/relevant software to be used as recommended by AICTE/UBTE/NITTTR, Chandigarh.

2. http://swayam.gov.in .

3. Theory of Machine by Thomas Beven

4. Theory of Machine by Balani

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Electric Vehicles, III Semester

EV 303 - Thermo-fluid Engineering

Course Objectives:

The objective of this course is to develop ability and gain insight into the process of problem-solving, with emphasis on thermodynamics and Fluid Mechanics .

Learning Outcomes

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

- Know about the basic concepts, statement and applications of Zeroth Law, First Law and Second Law of Thermodynamics
- To understand the concept of entropy, change in entropy, Available & Unavailable energy, concept of Availability
- Learn about pure substances, steam, properties of steam, determination of dryness fraction ,enthalpy, entropy and internal energy of different types of steam using steam table and Mollier diagram
- To have knowledge of basic properties of fluid, Hydrostatics, Buoyancy, Metacentre and stability conditions of floating bodies
- Derive and solve problems related to Euler's equation, Bernoulli's equation ,Application of Bernoulli's Equation in Venturi meter, Orifice meter, Pitot Tube (working principle), Momentum equation

Syllabus:

Unit 1: 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.

Unit 2 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, Clausious Inequality , Entropy, T-S diagrams, Available & Unavailable energy Availability

Unit 3 : Properties of Steam : Pure Substance, Phase, Phase-transformations, formation of steam, properties of steam, PVT surface, HS,TS,PV,PH,TV diagram, measurement of dryness fraction using calorimeter, Use of steam tables and Mollier chart to determine properties of steam.

Unit 4: Fluid Properties: Introduction, fluid and the continuum, fluid properties, surface tension, Newton's laws of viscosity and it's coefficients, Types of fluids, Pascal's Law, Hydrostatic Law, hydrostatics and buoyancy, meta centre and met centric height, stability of floating bodies and submerged bodies.

Unit 5 : Fluid Kinematics and Dynamics: Kinematics: Types of fluid flow, stream line, path line and streak line, types of flow and types of motion, local and connective acceleration, continuity equation of one, two and three dimensions, Velocity potential function, Stream Function, Laplace equation, circulation, flow nets.

Fluid Dynamics: Euler's equation, Bernoulli's equation ,Application of Bernouli's Equation: Venturimeter, Orifice meter, Pitot Tube, Momentum equation ,Impulse Momentum Equation and moment of momentum equation, their applications,

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

References:

1. Nag P.K.; Engineering Thermodynamics; Mc Graw Hills Fifth Edition
2. Cengel Y; Thermodynamics; MC Graw Hills ,Eight Edition
3. Dwivedi K.K. , Pandey Mukesh. Engineering Thermodynamics, Dhanpat Rai & Co.
4. Chattopadhya P , Engineering Thermodynamics Second Edition,OXFORD University Press
5. Yadav R. Applied Thermodynamics , Central Publishing house Allahabad
6. Khurmi R.S. ,Thermal Engineering, S Chand
7. Dwivedi K.K.,Pandey M.,Gupta B. Fundamentals of Mechanical Engineering,Dhanpat Rai & Co.Delhi
8. Rajput R.K. ,Thermal Engineering, Laxmi Publication
9. Domkundwar Thermal Engineering, Dhanpat Rai & Co.
10. Bansal R.K. Fluid Mechanics Laxmi Publication
11. ModI and Seth, Fluid Mechanics
12. Shames, Fluid Mechanics, Tata McGraw Hills

Suggested List of Experiments:

1. To investigate the first law and Second law of thermodynamic using heat Engine
2. Determination of Dryness Fraction of Steam using Separating calorimeter
3. Determination of Dryness Fraction of Steam using Throttling calorimeter
4. Determination of Dryness Fraction of Steam using Separating and throttling calorimeter

5. Study of the processes of Heat Engine
6. To determine the flow rate of a fluid by using venturimeter apparatus.
7. To determine the flow rate of a fluid by using Orifice meter apparatus.
8. To demonstrate Bernoulli's law by using Bernoulli's principle demonstrator

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Electric Vehicles, III Semester

EV 304 - Fundamentals of Electric Vehicles

COURSE OBJECTIVES

1. Explain electric, hybrid electric and plug-in hybrid electric vehicle (PHEV), their architecture, technologies and fundamentals
2. Explain the design, component sizing of the power electronics converters and various electric drives suitable for hybrid electric vehicles
3. Discuss different energy storage technologies used for hybrid electric vehicles and their control and energy balancing techniques
4. Demonstrate different configurations of electric vehicles and charging techniques

COURSE OUTCOMES

After completing the course, the students will be able to:

1: Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.

2: Analyze the use of different power electronics converters and electrical machines in hybrid electric vehicles.

3: Able to interpret the working of different configurations of electric vehicles and its components, hybrid vehicle configurations

4: Explain the use of different energy storage systems used for hybrid electric vehicles, their control techniques, and select appropriate energy balancing technology

5: Ability to understand the control and configurations of HEV charging stations.

UNIT 1

HEV Fundamentals: Vehicle Basics, vehicle model, Vehicle Resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Dynamic Equation Tire–Ground Adhesion and Maximum Tractive Effort, Power Train Tractive Effort and Vehicle Speed, EV Power train Component Sizing. Hybridization of the Automobile:

UNIT 2

Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV) and vehicle architectures: Series Hybrid Vehicle, Parallel Hybrid Vehicle, Basics of Fuel Cell Vehicles (FCVs).

UNIT 3

Power Electronics in HEVs: Power electronics circuits used for control and distribution of electric power in DC-DC, AC-DC, DC-AC converters used for HEV.
Electric Machines and Drives in HEVs: Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, Switched Reluctance Motor, BLDC motor, Design and Sizing of Traction Motors.

UNIT 4

Batteries, Ultra capacitor, Fuel Cells, and Controls: Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System.

UNIT 5

EV Charging Technologies: Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging.

TEXT BOOKS

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press , 2004
2. Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press , 2007
3. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley , 2003
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, *Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*, John Wiley & Sons Ltd. , 2011

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Electric Vehicles, III Semester

EV 305 - Energy Storage & Management System

Course Objectives:

Objective of introducing this course is to familiarize students about energy storage systems, its importance, electrical energy storage systems, hybrid energy storage systems, storage for renewable energy systems and recent **advancement in Energy Storage and management Systems**

Syllabus:

Unit I : Introduction to energy storage for power systems: Role of energy storage systems, applications. Overview of energy storage technologies**,** Thermal, Mechanical, Chemical, Electrochemical, Electrical. Efficiency of energy storage systems.

Unit II : Electrical energy storage: Batteries, Super capacitors, Superconducting Magnetic Energy Storage (SMES), charging methodologies, SoC, SoH estimation techniques. Hydrogen production and storage, fuel cells. Mobile storage system**;** electric vehicle, G2V, V2G.

Unit III: Hybrid Energy storage systems: configurations and applications. importance of Hybrid systems, advantages and disadvantages.

Unit IV : Storage for renewable energy systems: Solar energy, Wind energy, Pumped hydro energy, fuel cells. Energy storage in Micro-grid and Smart grid. Energy Management with storage systems, Battery SCADA, Increase of energy conversion efficiencies by introducing energy storage.

Unit V: Recent Advancement in Energy Storage and Management Systems: Simulation of energy storage systems and its management, smart park, Electric Vehicle charging facility, HESS in micro-grid and smart grid, microbial fuel cell, hydrogen fuel cell.

REFERENCE BOOKS

1. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN – 978-1-84919-219-4), 2011

2. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.

3. A. R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN – 13:9789380090122), 2011.

4. Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010.

5. Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) – A

National Laboratory of the U.S. Department of Energy – Technical Report NREL/ TP6A2-47187, January 2010.

Suggested List of Experiments:

1. Study of energy storage technologies**,** Thermal, Mechanical, Chemical, Electrochemical, Electrical..

2. Study of Hybrid Energy storage systems.

3. Study of storage for renewable energy systems such as solar energy, wind energy, pumped hydro energy

4. Study of Hydrogen fuel cells.

5. Simulation of energy storage systems and its management

6. Study and Simulation of Electric Vehicle charging facility

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Electric Vehicles, III Semester

EV 306 - Thermal Engineering Lab

Suggested List of Experiments:

1. To study low pressure boilers and their accessories and mountings.

2. To study high pressure boilers and their accessories and mountings.

3. To prepare heat balance sheet for given boiler.

4. To find the condenser efficiencies.

5. To study cooling tower and find its efficiency.

6. To study and find volumetric efficiency of a reciprocating air compressor.

7. To find dryness fraction of steam by separating and throttling calorimeter

8. Performance Test and Heat Balance Test on 4 Stroke Diesel Engine

9. Performance Test on Two Stroke Petrol Engine.

10.. Performance Test on Four Stroke Petrol Engine .

11. Morse Test On Four Cylinder Four Stroke Petrol Engine.

12. Study of Four Stroke Single Cylinder Diesel Engine with Mechanical Rope Brake Loading.
