



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India
DEPARTMENT OF AUTOMOBILE ENGINEERING

COURSE STRUCTURE-R19

COURSE STRUCTURE AND SYLLABUS

For

B. TECH AUTOMOBILE ENGINEERING

(Applicable for batches admitted from 2019-2020)



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India



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DEPARTMENT OF AUTOMOBILE ENGINEERING

IV Year - I Semester

| Course Code | Subjects | L | T | P | Credits |
|---|--|---|---|---|---------|
| ME4117 | Industrial Engineering & Management | 3 | 0 | 0 | 0 |
| AU 4114 | Vehicle Dynamics | 3 | 0 | 0 | 3 |
| AU 4115 | Vehicle Body Engineering | 3 | 0 | 0 | 3 |
| AU 4116 | Alternative Energy sources for Automobiles | 3 | 0 | 0 | 3 |
| ME 4118 AU 4117 AU 4118 ME 4119 AU 4119 | Elective I 1. CAD/CAM 2. Two and Three Wheelers 3. Automotive Aerodynamics 4. Finite Element Methods 5. Vehicle Infotronics | 3 | 0 | 0 | 3 |
| ME 4120 ME 4121 ME 4122 ME 4123 CS 4101 | Elective II 1. Mechatronics 2. Computational Fluid Dynamics 3. Condition Monitoring 4. Managerial Economics and financial analysis 5. Internet of Things | 3 | 0 | 0 | 3 |
| AU 4120 | Vehicle Design and simulation Lab | | | | 2 |
| PROJ 4103 | Project I | 0 | 0 | 6 | 2 |
| Total Credits | | | | | 19 |

IV Year - II Semester

| Course Code | Subjects | L | T | P | Credits |
|-------------------------------|--|---|---|----|---------|
| AU 4221 | Noise, Vibrations and Harshness | 3 | 0 | 0 | 3 |
| AU 4222 | Vehicle Maintenance | 3 | 0 | 0 | 3 |
| AU 4223 | Certification and Homologation | 3 | 0 | 0 | 3 |
| AU 4224 AU 4225 AU 4226 | Elective III 1. Automotive Safety 2. Automotive HVAC 3. Special Purpose Vehicles | 3 | 0 | 0 | 3 |
| PROJ 4204 | Project II | 0 | 0 | 12 | 8 |
| Total Credits | | | | | 20 |

Total Course Credits— 40+41 + 40+ 39 = 160



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|--|----------|----------|----------|----------|
| IV Year - I Semester | L | T | P | C |
| | 3 | 0 | 0 | 0 |
| INDUSTRIAL ENGINEERING AND MANAGEMENT | | | | |

Course Objectives:

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering
2. To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
3. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
4. To enable students to understand their role as engineers and their impact to society at the national and global context.

Unit – I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

Unit – II

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance.

Unit – III

OPERATIONS MANAGEMENT: Importance, types of production, applications, workstudy, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs,

Unit – IV

STATISTICAL QUALITY CONTROL: Quality control, its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – \bar{X} and R – charts \bar{X} AND S charts and their applications, numerical examples.

TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. six sigma – definition, basic concepts

Unit – V

RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

Unit - VI



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VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

PROJECT MANAGEMENT: PERT, CPM – differences & applications, critical path, determination of floats, importance, project crashing, smoothing and numerical examples.

TEXT BOOKS:

1. Industrial Engineering and management / O.P Khanna/Khanna Publishers.
2. Industrial Engineering and Production Management/Martand Telsang/S.Chand & Company Ltd. New Delhi

REFERENCE BOOKS:

1. Industrial Management / Bhattacharya DK/Vikas publishers
2. Operations Management / J.G Monks/McGrawHill Publishers.
3. Industrial Engineering and Management Science/ T. R. Banga, S. C. Sharma, N. K. Agarwal/Khanna Publishers
4. Principles of Management /Koontz O' Donnel/McGraw Hill Publishers.
5. Statistical Quality Control /Gupta/Khanna Publishers
6. Industrial Engineering and Management /NVS Raju/Cengage Publishers

COURSE OUTCOME:

Upon successful completion of this course you should be able to:

1. Design and conduct experiments, analyse, interpret data and synthesise valid conclusions
2. Design a system, component, or process, and synthesise solutions to achieve desired needs
3. Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints
4. Function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management



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|-----------------------------|----------|----------|----------|----------|
| IV Year - I Semester | L | T | P | C |
| | 3 | 0 | 0 | 3 |
| VEHICLE DYNAMICS | | | | |

UNIT I

Introduction: Hypothetical vehicle control loop, Fundamental Approach, Vehicle coordinates, motion variables. Forces – Dynamic axle loads, Static loads on level ground, aerodynamic forces on body, hitch forces – problems

UNIT-II

Acceleration & Braking Performance – Power limited acceleration, Static loads on level ground, aerodynamic forces on body, Fundamental Expressions, Constant retardation, Wind Resistance, Power, Braking forces, Brakes: disc and drum, front, rear and four wheel braking, Road friction rolling resistance, problems.

UNIT-III

Road Loads: Aerodynamic, Mechanics of pressure distribution – Aerodynamic forces: lift & drag, Spoilers, Lift force, side force and roll, pitch and yaw moments, Crosswind sensitivity. Rolling Resistance, Factors affecting pressure, velocity, slip temperature, etc – Total road loads – Fuel Economy Effects.

UNIT-IV

Ride: Excitation sources – road roughness, wheel assembly, driveline excitation, engine transmission. Vehicle response properties: Suspension isolation, suspension stiffness & damping Wheel Hop Resonance. Road-tyre friction – dynamic response of tires – Rigid body bounce, pitch motion. Perception of ride and other vibration forms, Problems.

UNIT-V

Steady – State Cornering: Introduction, Low and high speed turning –Tire cornering forces, governing expressions, understeer gradient, oversteer and neutral conditions. Characteristic speed, critical speed, yaw velocity gain, sideslip angle, static margin. Suspension effects on cornering: roll moment distribution – effect of tractive forces on cornering – Problems

TEXT BOOKS:

1. Thomas D.Gillespie, “ Fundamentals of Vehicle dynamics.” Society of Automotive engineers Inc, 2014
2. Wong H, Theory of Ground Vehicles, McGraw Hill, Second edition, 2006.

REFERENCES:

1. Hans B Pacejka, Tire and Vehicle Dynamics,3rd Edition, Elsevier Ltd., 2012.
2. Amitosh D, Vehicle Dynamics, Galgotia Book Ltd., 2010.
3. Rao V Dukkupati, Road Vehicle Dynamics, Springer 2008
4. Werner and Karl, Ground Vehicle Dynamics, Springer Berlin Heidelberg, 2008.



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COURSE OUTCOMES:

- CO1 Understand the principles underlying the development and design of road vehicles under the influence of dynamic loads.
- CO2 Analyze the performance and establish the design specifications for the acceleration and braking conditions.
- CO3 Model, simulate and analyze the conventional road vehicles for better ride comfort.
- CO4 Analyze the cornering forces and effects of tractive forces on cornering
- CO5 Design suspension systems for better damping and comfort



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| IV Year - I Semester | L | T | P | C |
| | 3 | 0 | 0 | 3 |
| VEHICLE BODY ENGINEERING | | | | |

Car Body Details

Types: Saloon, Convertibles, Limousine, Estate Car, Racing and Sports Car. Visibility: Regulations, Driver's Visibility, Tests for Visibility, Methods of Improving Visibility and Space in Cars. Safety: Safety Design, Safety Equipments for Cars. Car Body Construction; Design Criteria, Prototype Making, Initial Tests, Crash Tests on Full Scale Model, Dummies and Instrumentation

Vehicle Aerodynamics

Objectives. Vehicle Drag and Types; Various Types of Forces and Moments, Effects of Forces and Moments, Side Wind Effects on Forces and Moments, Various Body Optimization Techniques for Minimum Drag, Wind Tunnel Testing: Flow Visualization Techniques, Scale Model Testing, Component Balance to Measure Forces and Moments.

Bus Body Details

Types: Mini Bus, Single Decker, Double-Decker, Two Level and Articulated Bus. Bus Body Layout; Floor Height, Engine Location, Entrance and Exit Location, Seating Dimensions. Constructional Details: Frame Construction, Double Skin Construction, Types of Metal Sections used, Regulations, Conventional and Integral Type Construction.

Commercial Vehicle Details

Types of Body; Flat Platform, Drop Side, Fixed Side, Tipper Body, Tanker Body, Light Commercial Vehicle Body Types. Dimensions of Driver's Seat Relation to Controls. Drivers Cab Design.

Body Materials, Trim and Mechanisms

Steel Sheet, Timber, Plastic, Grp, Properties of Materials; Corrosion, Anticorrosion Methods. Selection of Paint and Painting Process. Body Trim Items. Body Mechanisms

Text Books

1. James E Duffy, "Modern Automotive Technology", Goodheart-Willcox; Seventh Edition, 2011
2. Jack Erjavec, "Automotive Techology – A systems approach", Cengage Learning, 2009,

Reference Books:

1. Geoff Davies, Materials for Automotive Bodies, Elsevier, Butterworth Heinemann, ISBN 0 7506 5692 1, 2003
2. Body Engineering , S. F. Page
3. Automotive Chassis – P.M. Heldt, Chilton & Co. 1952



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| IV Year - I Semester | L | T | P | C |
| | 3 | 0 | 0 | 3 |
| ALTERNATIVE ENERGY SOURCES FOR AUTOMOBILES | | | | |

Course Objectives: To impart the necessity of finding alternative energy sources for automobiles. To understand merits and demerits, performance characteristics of various sources of fuels and their comparison.

UNIT I

CONVENTIONAL FUELS FOR I.C. ENGINES

Petroleum based conventional fuels for SI and CI engine, Demand and Availability of crude oil – vehicle population increase – national and international standards for conventional and alternative fuels.

Desirable characteristics of SI Engine fuels – Petrol – Properties, Specification, chemical structure, Volatility characteristics, knock rating and additives. Desirable characteristics of CI Engine fuels – Diesel – Properties, Specification, chemical structure, Ignition quality, Cetane rating and additives.

UNIT II

ALCOHOLS AS FUELS

Availability of different alternative fuels for engines. Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of alcohol fuels

UNIT III

VEGETABLE OILS AND BIODIESEL AS FUELS

Properties of Vegetable oils and biodiesel- Methods of using vegetable oils – Blending, preheating, and emulsification – Preparation of biodiesel from non-edible, edible oil and Algae - Performance, combustion and emission Characteristics in diesel engines. Advantages and disadvantages of Vegetable oils and biodiesel

UNIT IV

HYDROGEN AS FUEL

Hydrogen – Properties, Production methods, storage and safety aspects. Issues & limitation in Hydrogen. Methods of using hydrogen in engines. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Hydrogen fuel.

UNIT V

BIOGAS, CNG AND LPG AS FUELS

Biogas, Compressed Natural gas (CNG) and LPG – Properties and production methods. CO₂ and H₂S scrubbing in Biogas, Modifications required for use in Engines- Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Gaseous fuels. Working of LPG and CNG kits used in automotive engines.



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REFERENCES

1. Arumugam S. Ramadhas, “Alternative Fuels for Transportation” CRC Press, 2011.
2. Ayhan Demirbas and M. Fatih Demirbas, “Algae Energy-Algae as a New Source of Biodiesel”, Springer-Verlag London Limited 2010.
3. Ayhan Demirbas, ‘Biodiesel A Realistic Fuel Alternative for Diesel Engines’, Springer-Verlag London Limited 2008
4. David M. Mousdale, “Introduction to Biofuels”, CRC Press, 2015.
5. Ganesan.V., “Internal Combustion Engineering”, Tata McGraw-Hill Publishing Co., New Delhi, 2003.
6. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
7. M. K. Gajendra Babu and K. A. Subramanian, “Alternative Transportation Fuels-Utilisation in Combustion Engines”, CRC Press, 2013.
8. M.L. Mathur, R.P.Sharma “A course in internal combustion engines”, Dhanpatrai publication, 2003.
9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

OUTCOMES:

By the end of this course, students will be able to

1. Student will possess a comprehensive understanding of available alternative fuels for IC engines. They will possess complete knowledge on producing different biofuels, modifying them and using them in IC engines
2. Students will acquire the skills in developing new technologies for alternative fuels efficiently in IC engines.
3. Students will demonstrate the importance of using alternative fuels for sustainable energy supply and for emission control in IC engines.



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| IV Year - I Semester | L | T | P | C |
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| | 3 | 0 | 0 | 3 |
| CAD/CAM (ELECTIVE -I) | | | | |

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the basic fundamentals of computer aided design and manufacturing.
2. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
4. To learn the part programming, importance of group technology, computer aided process planning, computer aided quality control
5. To learn the overall configuration and elements of computer integrated manufacturing systems.

UNIT – I

Introduction to CAD/CAM, product cycle, CAD / CAM Hardware, basic structure.

COMPUTER GRAPHICS: Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 2D and 3D transformations, mathematics of projections, clipping, hidden surface removal.

UNIT – II

GEOMETRIC MODELING: Requirements, geometric models, geometric construction models, curve representation methods, parametric representation of various curves: cubic spline, bezier curves. surface representation methods, Solid modelling.

UNIT – III

PART PROGRAMMING FOR NC MACHINES: NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming. Direct Numerical Control, Adaptive Control.

UNIT – IV

GROUP TECHNOLOGY: Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types. FMS-Introduction, Equipment, Tool management systems, Layouts, FMS Control

UNIT – V

COMPUTER INTEGRATED MANUFACTURING SYSTEMS: Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits.



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COMPUTER AIDED QUALITY CONTROL: Terminology used in quality control, use of computers in Quality control. Inspection methods- contact and noncontact types, computer aided testing, integration of CAQC with CAD/CAM.

TEXT BOOKS:

1. CAD / CAM Principles and Applications/PN Rao / McGraw-Hill
2. Automation, Production systems & Computer integrated Manufacturing/ M.P. Groover/Pearson Education

REFERENCES:

1. Mastering CAD / CAM / Ibrahim Zeid / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson learning, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang/Elsevier Publishers

Course Outcomes:

At the end of the course the students shall be able to:

1. Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix
2. Describe the use of GT and CAPP for the product development
3. Identify the various elements and their activities in the Computer Integrated Manufacturing Systems.



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| IV Year - I Semester | | L | T | P | C |
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| | | 3 | 0 | 0 | 3 |
| TWO AND THREE WHEELERS (ELECTIVE –I) | | | | | |

OBJECTIVES:

The objective of this course is to make the students to know and understand the constructional details, operating characteristics and design aspects of Two and Three wheelers.

UNIT I INTRODUCTION

Classifications- design considerations –weight and dimension limitations – requirements, stability problems, gyroscopic effect- pendulum effect of two and three wheelers.

UNIT II POWER UNITS, IGNITION SYSTEMS ELECTRICAL & BRAKING SYSTEMS

2 stoke and 4 stoke engines. Design criteria for engines – design of cylinders, cylinder head, cooling fins, crank case, connecting rod and crank shaft. Carburettor types and design. Wiring layout for two wheelers. Braking system in two wheelers.

UNIT III CLUTCHES AND TRANSMISSION

Types of clutches. Design of clutch system. Gears for two and three wheelers. Design of gear box and gear change mechanism. Belt, chain and shaft drive. Free wheeling devices, starting systems.

UNIT IV FRAMES, SUSPENSION, WHEELS AND TYRES

Types of frames. Wheel frames- construction design of frames for fatigue strength, torsional stiffness and lateral stability. Front and rear forks. Springs for suspension, Dampers, constructional details of wheel and tyres.

UNIT V THREE WHEELERS

Auto rickshaws, different types, Pick-Ups and delivery type vehicle, frames and transmission, wheel types, wheel mountings attachment, tyre types. Brake systems.

REFERENCES

1. 'Cycle Motor Manual', Templeton Press Ltd., London, 1992.
2. Irving P.E., "Motor Cycle Engineering", Temple Press Book, London, 1964
3. Johns.B.A., 'Motorcycles', Good Heartwill, 1984.
4. M.M.Griffin., 'Motor cycles from inside and outside', Prentice Hall Inc, New Jersey, 1978.
5. Marshal Cavandedish, 'Encyclopedia of Motor cycling', New York, 1989
6. Servicing Manuals- various motor cycles, Scooters, Mopeds and three wheelers.
7. Srinivasan.S., 'Motor cycle, Scooter, Mopeds', New century book house, 1988



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OUTCOMES:

To students will have the basic knowledge on various two wheelers and its technology along with its functions. At the end of the course the students will have through knowledge over different frames, suspension system and transmission unit used on various two and three wheeler vehicles



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| IV Year - I Semester | L | T | P | C |
| | 3 | 0 | 0 | 3 |
| AUTOMOTIVE AERO DYNAMICS (ELECTIVE -I) | | | | |

Unit 1 – Fundamentals of Aerodynamics

Scope – Development trends – Flow phenomena related to vehicles – External and Internal flow problems – Performance of cars and light vans – Resistance to vehicle motion – Drag – Types of drag – Flow field around car – Aerodynamic development of cars – Optimization of car bodies for low drag

Unit 2 - Stability, Safety and Comfort

The origin of forces and moments – effects – vehicle dynamics under side wind – Force and Moment coefficients – Safety limit – dirt accumulation on vehicle – wind noise – Air flow around individual components – High performance vehicles – Very log drag cars – Design alternatives – High efficiency radiator arrangement – Development and simulation methods

Unit 3 - Wind Tunnels and Test Techniques

Principles of wind technology – Limitations of simulation – Scale models – Existing automobile wind tunnels – Climatic tunnels – Measuring equipment and transducers. Pressure measurement – velocity measurements – Flow visualization techniques – Road testing methods – Wind noise measurements

Unit 4 - Application of CFD

Methods to solve Navier–Stokes equation – Forces acting in a fluid element – Compressibility effects in a flow field – Inviscid flow – Governing equations – Irrotation flow field and consequences – Potential flows – Boundary layer methods – Numerical modeling of fluid flow around vehicle body

Unit 5 – Aerodynamic Design

Development and simulation methods –cars, buses, trucks

Text Book:

Yomi Obidi, ‘Theory and Applications of Aerodynamics for Ground Vehicles’, SAE Publications, 2014

References

1. W.H. Hucho, ‘Aerodynamics of Road Vehicles’, SAE Publications, 4th edition 1998.
2. R.McCallen, Browand, Ross, “The Aerodynamics of Heavy Vehicles”, Springer, 2004
3. Smits, Lim, “Flow Visualization: Techniques and Examples”, 2nd Edition, Imperial College, 2012
4. Schlichting, H, Kirsten K. ‘Boundary Layer Theory’, Springer, 2000.



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| IV Year - I Semester | | L | T | P | C |
| | | 3 | 0 | 0 | 3 |
| FINITE ELEMENT METHODS (ELECTIVE –I) | | | | | |

Course Objectives:

1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures
3. To learn and apply finite element solutions to structural, thermal and dynamic problems.
4. Learn to model complex geometry problems and solution techniques.

UNIT-I

Introduction to finite element method, stress and equilibrium, strain – displacement relations, stress – strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one dimensional problems.

Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

UNIT – II

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT – III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems.

UNIT-IV

Higher order and isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

UNIT – V

Steady state heat transfer analysis : one dimensional analysis of a fin and two dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion. Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

TEXT BOOKS:

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Introduction to Finite Elements in Engineering/ Tirupathi R. Chandrupatla, Ashok D.Belegundu, Pearson Publishers.



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References:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho & Shah /Pearson publishers
2. An introduction to Finite Element Method / JN Reddy / McGraw Hill
3. The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons (ASIA) Pte Ltd.

Course outcomes:

Upon successful completion of this course you should be able to:

1. Understand the concepts behind variational methods and weighted residual methods in FEM
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element .
3. Develop element characteristic equation procedure and generate global equations.
4. Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.
5. Able to apply the FE procedure to field problems like heat transfer.



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| VEHICLE INFOTRONICS (ELECTIVE –I) | | | | |

Overview of Infotronics:

Concept of Infotronics, Web-enabled Vs Web Based systems, Applications of Infotronics, Vehicle buses and protocols – LIN, CAN, MOST & Flexray.

Systems in vehicle:

Smart control of Vehicle[ESP] dynamics, drive Electronic Throttle control by wire, active suspensions/mounting system, Automated Guided Vehicles(AGV), Multi-disciplinary optimization in Vehicles (MDO) and advanced propulsion systems(APS), Radio Communication Technologies For Vehicle Information Systems, IEEE 802.11 and DSRC.

Telematics:

Global positioning systems, geographical information systems, navigation systems, automotive vision system, road recognition, driver assistance systems.

Intelligent vehicle Control

Active and Semi active suspensions/Mounts for NVH, Optimization and stability of Hydraulic Engine mounts and Bushing in Vehicle, Rollover control and Active stability control, combined control of ride comfort in passenger cars, Active Roll over control in hydraulically actuated articulated vehicles, intelligent drive by wire vehicles, Design and realization of steer and brake by wire. Electric and hybrid vehicle - Requirements, Introduction, characteristics, different types and Design.

Adaptive Control System

Conventional control schemes, system model for adaptive control, Design of self-tuning controllers, ACC overview, system based on ACC, Stop and Go, Anti- collision system, Impact of ACC on traffic and drivers, Adaptive noise control, automatic and adaptive control of highway traffic and moving vehicles. Power steering and power window: Requirements, Introduction, characteristics.

TEXT BOOKS:

1. Intelligent Vehicle Technology by L VIACIC, M PARENT, F HARA, Butterworth-Heinemann publication.
2. Navigation and Intelligent transportation systems By Ronald K. Jurgen, SAE.

REFERENCE BOOKS:

1. Robert Bosch, Automotive Hand Book by SAE
2. Understanding Automotive Electronics by Willam B. Ribbens, SAE
3. Understanding Automotive Electronics by Bechhold, SAE.



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| IV Year - I Semester | L | T | P | C |
| | 3 | 0 | 0 | 3 |
| MECHATRONICS (ELECTIVE –II) | | | | |

Course Objective

The main objective of this course is to introduce the integrative nature of Mechatronics. To describe the different components and devices of mechatronics systems.

UNIT-I

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

UNIT-III

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-IV

System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives.

UNIT-V

Dynamic models and analogies, System response. Process Controllers – Digital Controllers, Programmable Logic Controllers, Design of mechatronics systems & future trends.

TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition



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REFERENCES:

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/Thomson Publications,Chennai.
3. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdas shetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W. Bolton/ Pearson, 2012
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

COURSE OUTCOMES:

After completion of this course, the student shall be able to use the various mechatronics systems devices and components in the design of electro mechanical systems.



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| IV Year - I Semester | | L | T | P | C |
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| COMPUTATIONAL FLUID DYNAMICS (ELECTIVE –II) | | | | | |

Course Objectives:

The course aims at providing required numerical and software techniques for solving various engineering problems involving fluid flow.

UNIT-I

Number system and errors, representation of integers, fractions, floating point arithmetic, loss of significance and error propagation, condition and instability, computational methods for error estimation, convergence of sequences.

Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices.

UNIT-II

conservation of mass, Newton's second law of motion, expanded forms of navier-stokes equations, conservation of energy principle, special forms of the Navier-stokes equations.

Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation.

UNIT-III

Finite difference applications in heat conduction and convection – heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.

Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

UNIT –IV

Introduction to first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modelling, conservative property, the upwind scheme.

UNIT –V

FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

TEXT BOOKS:

1. Numerical heat transfer and fluid flow / Suhas V. Patankar/Butter-worth Publishers
2. Computational fluid dynamics - Basics with applications /John. D. Anderson / Mc Graw Hill.



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REFERENCES:

1. Computational Fluid Flow and Heat Transfer/ Niyogi/Pearson Publications
2. Fundamentals of Computational Fluid Dynamics /Tapan K. Sengupta / Universities Press.
3. Computational fluid dynamics: An introduction, 3rd edition/John.F Wendt/Springer publishers

COURSE OUTCOMES:

After undergoing the course the student shall be able to apply various numerical tools like finite volume, finite difference etc for solving the different fluid flow heat transfer problems.



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| IV Year - I Semester | | L | T | P | C |
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| CONDITION MONITORING (ELECTIVE –II) | | | | | |

UNIT – I

Introduction to maintenance and condition based maintenance, Definition, system approach, objectives, responsibilities of maintenance department, maintenance strategies, principles of maintenance, concepts of maintainability, availability and reliability, implementation of CBM, comparison of CBM with other maintenance techniques and case studies (overview). Introduction to condition monitoring, Basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring.

UNIT – II

Basic signal processing techniques Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis. Wavelet Transform Introduction to Wavelets, Continuous Wavelet Transform (CWT), Discrete Wavelet Transform (DWT), Wavelet Packet Transform (WPT), types of wavelets – Haar wavelets, Shannon wavelets, Meyer wavelets, Daubechies wavelets, Coifmann wavelets and applications of wavelets.

UNIT - III

Vibration Monitoring, Introduction, vibration data collection, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration analysis.

Rotating and reciprocating machines, Vibration signals from rotating and reciprocating machines – signal classification, signals generated by rotating machines, signals generated by reciprocating machines.

UNIT – IV

Mechanical fault diagnosis, Wear monitoring and lubricant analysis - sources of contamination, techniques, Spectrometric, Oil Analysis Procedure (SOAP) and ferrography. Nondestructive testing techniques, Measurement of surface and subsurface flaws – liquid penetrant inspection, eddy current inspection, radiographic inspection, ultrasonic inspection.

UNIT – V

Condition monitoring of rolling element bearings and gear, Introduction, construction, types of faults, rolling element bearing diagnostics and gear diagnostics. Tool wear monitoring, Introduction, techniques and case studies.



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TEXT BOOKS:

1. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
2. R.A.Collacot – Mechanical Fault Diagnosis – Chapman and Hall Ltd., 1977.
3. ISTE Course material on Condition Monitoring.
4. R.C.Mishra, K.Pathak – Maintenance Engineering and Management, Prentice Hall of India Pvt. Ltd., 2002.
5. K. P. Soman, K. I. Ramachandran, N. G. Resmi – Insight into wavelet from theory to practice, Third Edition, Prentice Hall of India,

REFERENCES BOOKS:

1. John S.Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books,1993.
2. Elsevier-“Hand book of Condition Monitoring” ELSEVIER SCIENCE
3. R.A.Collacott, “Vibration monitoring and diagnosis”, Wiley,1979.
4. RaoJ.S.,“VibratoryConditionMonitoringofMachines”,CRCPress,2000.
5. “ConditionMonitoringmanual”,NationalProductivityCouncil,NewDelhi.

Course Outcomes:

At the end of this course the student shall be able to:

1. Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.
2. Implement the basic signal processing techniques.
3. Understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
4. Understand the significance of mechanical fault diagnosis and non-destructive testing techniques in monitoring and maintenance.
5. Study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.



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| IV Year - I Semester | | L | T | P | C |
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| MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS (ELECTIVE –II) | | | | | |

Course Objectives:

- The Learning objectives of this paper are to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting.
- To familiarize about the Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation.
- Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-I**Introduction to Managerial Economics and demand Analysis:**

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects – Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

Unit – II:**Theories of Production and Cost Analyses:**

Theories of Production function- Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs-Fixed costs, Variable Costs and Total costs –Cost –Volume-Profit analysis-Determination of Breakeven point(problems)-Managerial significance and limitations of Breakeven point.

Unit – III:**Introduction to Markets, Theories of the Firm & Pricing Policies:**

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson’s models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing, Business Cycles : Meaning and Features – Phases of a Business Cycle. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and their forms.

Unit – IV:**Introduction to Accounting & Financing Analysis:**

Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow analysis (Problems)



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Unit – V:

Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

Course Outcomes:

- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for a product.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- The pupil is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

TEXT BOOKS:

A R Aryasri, Managerial Economics and Financial Analysis, The McGraw – Hill companies.

REFERENCES:

1. Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & Company Ltd,
2. JL Pappas and EF Brigham, Managerial Economics, Holt, R & W; New edition edition
3. N.P Srinivasn and M. SakthivelMurugan, Accounting for Management, S. Chand & Company Ltd,
4. MaheswariS.N, AnIntroduction to Accountancy, Vikas Publishing House Pvt Ltd
5. I.M Pandey, Financial Management , Vikas Publishing House Pvt Ltd
6. V. Maheswari, Managerial Economics, S. Chand & Company Ltd,



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| IV Year - I Semester | | L | T | P | C |
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| <u>INTERNET OF THINGS</u> (ELECTIVE –II) | | | | | |

UNIT I - Introduction to IoT

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II - IoT Architecture

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

UNIT III - IoT Protocols

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP – Security

UNIT IV - Building IoT with Raspberry PI & Arduino

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT V - Case Studies And Real-World Applications

Biometric Car Door opening system, Accident monitoring system, Engine oil and Coolant level monitoring system, Fleet and Driver Management system, Smart road communication system, Road Vehicle communication at hilly areas, real time car telematics tracking system.

Text Books:

1. Rajesh Singh, Anita Gehlot et.al., - Internet of Things in Automotive Industries and Road Safety: Electronic Circuits, program Coding and Cloud Servers , River publishers, ISBN- 978-87-7022-010-1.
2. Arshdeep Bahga, Vijay Madiseti, —Internet of Things – A hands-on approach, Universities Press, 2015



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References:

1. Arshdeep Bahga, Vijay Madiseti, —Internet of Things – A hands-on approach, Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.
3. Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
4. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012



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| VEHICLE DESIGN AND SIMULATION LAB | | | | |

PART-A - SIMULATION

LIST OF CHASSIS DESIGN EXPERIMENTS

1. Design and modeling of frame.
2. Design and Modeling of clutch assembly
3. Design and Modeling of constant mesh gearbox.
4. Design and Modeling of sliding mesh gearbox.
5. Design and Modeling of Propeller shaft with universal joint.
6. Design and Modeling of rear axle.
7. Design and Modeling of stub axle assembly.

Note: Preferably using software CATIA/UNIGRAPHICS/PROE or Equivalent licensed software

PART-B - COMPUTATIONAL

LIST OF EXPERIMENTS

1. FEATURES OF MATLAB
2. USES OF MATLAB
3. MATHEMATICAL PROBLEMS IN MATLAB
4. FORMULATION OF IDEAL AND REAL GAS PROBLEMS IN MATLAB PROGRAM.
5. DYNAMICS AND VIBRATION ANALYSIS-I IN MATLAB PROGRAM
6. THERMAL STRESS ANALYSIS OF PISTON-I IN MATLAB PROGRAM.
7. ANALYSIS OF KINEMATICS IN FOUR BAR MECHANISM IN MATLAB PROGRAM.

Note: Preferably using MAT LAB or other licensed software

PART-C – ANALYTICAL DESIGN

LIST OF EXPERIMENTS

1. Design and Analysis of steering system.
2. Design and Analysis of suspension system.
3. Design and Analysis of Frames.
4. Design and Analysis of Integration of subsystems to main system.
5. Behavioral Analysis of different road conditions on a green vehicle.
6. Design and simulation of Differential.
7. Design and simulation of Epicyclic (Gear box).



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Note: Preferably using software like ADAMS CAR / LOTUS / ABACUS / 3DX CATIA / NX or Equivalent licensed software

Course Objectives:

- i. To familiarize the students to use modeling software for modeling engine components.
- ii. To design chassis components with dimensions and strength requirements.
- iii. To learn the use of standard practices in modeling of components.
- iv. The use of modeling software to control the quality of the final engineered product.
- v. To visualize the complete assembly of the various system.

Course Outcomes:

Students will be able to visualize the automotive components with the help of modeling software.

- i. Make the modifications instantly if required at the initial stage itself.
- ii. Demonstrate the knowledge on designing components to withstand the loads and deformations.
- iii. Synthesize, analyze and document the design of the various components.
- iv. Demonstrate the ability to use engineering techniques for developing vehicle components with industry standards.