POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI

BE in Automobile Engineering

Scheme of Teaching and Examination 2024-25

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2024-25)

VII SEMESTER

Sl.No.	Course & Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Crédits
					Theory Lecture	Tutorial	Practical/ Drawing	Self study Component	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PEC	21AU71X	Professional Elective-II	AU	3	0	0	0	3	50	50	100	3
2	PEC	21AU72X	Professional Elective-III	AU	3	0	0	0	3	50	50	100	3
3	OEC	21AU73X	Open Elective-II	AU	3	0	0	0	3	50	50	100	3
4	OEC	21AU74X	Open Elective-III	AU	3	0	0	0	3	50	50	100	3
5	Project	21AUP75X	Project work	AU	0	0	6	0	3	50	50	100	10
6	AEC	21XXX76	Ability Enhancement Course (Online) 8-weeks		0	0	0	0	3	50	50	100	2
			Total =		**12**	**0**	**6**	**0**	**18**	**300**	**300**	**600**	**24**

Professional Elective-II	**Open Elective-II**
1. Mechanical Vibration (21AU711)	1. Non-Conventional Energy Sources (21AU73OE1)
2. Experimental Stress Analysis (21AU712)	2. Air Pollution Control(21AU73OE2)
3. Computer Integrated Manufacturing (21AU713)	
Professional Elective-III	**Open Elective-III**
1. VBE &EME (21AU721)	1. Transport Mangement & Economics (21AU74OE1)
2. Cryogenics (21AU722)	2. Hybrid & EV (21AU740E2)
3. Flexible Manufacturing Systems (21AU723)	

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VIII SEMESTER

Sl.No.	Course & Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Crédits
					Theory Lecture	Tutorial	Practical/ Drawing	Self study Component	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	Seminar	21AUS81	Technical Seminar	AU	0	0	2	0	0	100	0	100	1
2	Internship	21AUI82	Research/ Industry Internship	AU	0	0	0	0	03	100	100	200	15
			Total =		**0**	**0**	**02**	**0**	**03**	**200**	**100**	**300**	**16**

Professional Elective – II

Course Title: **MECHANICAL VIBRATIONS**		
Course Code	**21AU711**	CIE: 50
Number of Lecture Hours/Week	**3 hrs. (Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules-I		**Teaching Hours**
UNDAMPED FREE VIBRATION: Introduction, energy method, Newton's method and D'Alembert's principle single degree of freedom system, natural frequency, Rayleigh's method, stiffness of spring elements, effects of spring mass. **DAMPED FREE VIBRATION**: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, response study of viscous damped systems for cases of under damping and over damping, logarithmic decrement.		**09 Hours**
Modules-II		
FORCED VIBRATION: Single degree of freedom systems, steady state solution with viscous damping due to harmonic force solution by complex algebra, concept of response, reciprocating an rotating unbalance, vibration isolation- transmissibility ratio, energy dissipated by damping, equivalent viscous damping, structural damping, sharpness of resonance and base excitation. Vibration measuring instruments.		**08 Hours**
Modules-III		
SYSTEMS WITH TWO DEGREE OF FREEDOM: Introduction, Principle modes and normal modes. Co-ordinate coupling, generalized and Principle co-ordinate, free vibrations in terms of initial conditions, Lagrange's equation, semi-definite systems, forced oscillations, harmonic excitation.		**08 Hours**
Modules-IV		
VEHICLE VIBRATION AND HUMAN COMFORT: vehicle vibration with single degree of freedom of free vibration, forced vibration, vibration due to road roughness, vibration due to engine unbalance, transmissibility of engine mounting, compensated		**08 Hours**

suspension systems forced vibration. Human comfort criteria.	
Modules-V	
METHODS FOR MULTIDEGREE OF FREEDOM SYSTEMS: Introduction, influence coefficients, Maxwell's reciprocal theorem, Determination of natural frequencies using Dunkerley's equation, matrix iteration, Holzer's method, Stodola method	**09 Hours**

Question paper pattern:

Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.

2. Five full questions are to be answered selecting at least One full question from Each Module.
3. Each question should not have more than 4 sub divisions

Text books: 1. Mechanical Vibration – G.K. Grover, Nemchand & Brothers,1989
2. Vibration Theroy & Application – William I Thomson, Prentice Hall
3. Mechanical Vibration – V.P. Singh, Dhanpat Rai & company pvt. Ltd.

Reference Books:

1. Mechanical Vibration – Church, Wiley international.
2. Mechanics of Pneumatic Tyre – S.K. Clark, Prentice Hall
3. Theory & problems of Mechanical Vibration –William W. Seto, McGrawHill
4. Vibration Theory Mechanical Vibrations – S.S.Rao, Pearson Edu. Inc.
5. Mechanical Vibration Analysis – P. Srinivasan, TMH
6. Vibration and Noise for engineers-Kewal pujara & R.S.Pujara, Dhanpat Rai.

E books and online course materials:

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21AU711	**CO1**	Classify different types of vibration, Calculate natural frequency and other parameters of single Degree of freedom.
	CO2	Calculate natural frequency, logarithmic decrement & other parameters of single degree of freedom of Damped vibrating systems.
	CO3	Compute the response of Harmonic Excitation forces acting on One and Two degree of freedom.
	CO4	Analyse the human comfort due to road roughness, engine unbalance, compensated suspension systems.
	CO5	Analyse the concept of multi-degree of freedom of mechanical vibrating system

Course Title: **EXPERIMENTAL STRESS ANALYSIS**		
Course Code	**21AU712**	CIE: 50
Number of Lecture Hours/Week	**3 hrs. (Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules-I		**Teaching Hours**
INTRODUCTION: Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. General consideration in data analysis. **ELECTRICAL RESISTANCE STRAIN GAUGES**: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Whetstone's bridges, Constant current circuits.		**09 Hours**
Modules-II		
STRAIN ANALYSIS METHODS: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gauge, stress intensity factor. Force, Torque and strain measurements: Mass balance measurement, Elastic element for force measurements, torque measurement.		**08 Hours**
Modules-III		
P**HOTOELASTICITY**: Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinic & Isochromatic, Fringe order determination Fringe multiplication techniques, Calibration photo elastic model materials. Two-Dimensional Photoelasticity: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo elastic model materials, Materials for 2D photoelasticity.		**08 Hours**
Modules-IV		
THREE-DIMENSIONAL PHOTO ELASTICITY: Stress freezing method, Scattered light photoelasticity, Scattered light as an		

interior analyser and polarizer, Scattered light polariscope and stress data Analyses. Photo elastic (Birefringent) Coatings: Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson's, Stress separation techniques: Oblique incidence.	**08 Hours**
Modules-V	
BRITTLE COATINGS: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications. Moiré Methods: Moire fringes produced by mechanical interference .Geometrical approach, Displacement field approach to Moire fringe analysis, out of plane displacement measurements, Out of plane slope measurements .Applications and advantages.	**09 Hours**

Question paper pattern:

Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.

2. Five full questions are to be answered selecting at least One full question from Each Module.
3. Each question should not have more than 4 sub divisions

Text books:

1. Experimental Stress Analysis, Dally and Riley, McGraw Hill.
2. Experimental Stress Analysis, Sadhu Singh, Khanna publisher.
3. Experimental stress Analysis, Srinath L.S TaTa Mc Graw Hill.

Reference Books:

1. Photoelasticity Vol I and Vol II, M.M.Frocht, John Wiley & sons.
2. Strain Gauge Primer, Perry and Lissner,
3. Photo Elastic Stress Analysis, Kuske, Albrecht & Robertson John Wiley & Sons.
4. Motion Measurement and Stress Analysis, Dave and Adams,
5. Holman, Experimental Methods for Engineers, Tata McGraw-Hill Companies, 7th Edition, New York, 2007. 6. B. C. Nakra and K. K. Chaudhry, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Companies, Inc, New York, 7th Edition, 2006.

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21AU711	**CO1**	Impart basic knowledge of the elastic behaviour of solid bodies
	CO2	Competency with stress and strain gauges

	CO3	Apply photo-elastic methods in whole field stress analysis of solids
	CO4	Address experimental investigations with predictions made using other methods.
	CO5	Demonstrate various coating techniques.

Course Title: **COMPUTER INTEGRATED MANUFACTURING**		
Course Code	**21AU713**	CIE: 50
Number of Lecture Hours/Week	**3 hrs. (Theory)**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules-I		**Teaching Hours**
COMPUTER INTEGRATED MANUFACTURING: Introduction of CIM, CIM hardware and software, Role of the Elements of CIM system, Product development cycle, Sequential and concurrent engineering, Soft and hard prototyping. **FINITE ELEMENTAL MODELING AND ANALYSIS IN CIM**: Introduction, General steps involved in FEM, Types of analysis, element and load types, simple numerical problems.		**09 Hours**
Modules-II		
COMPUTER NUMERICAL CONTROL: Basic components of NC, Concepts of CNC, DNC, machining centres and their advantages. CNC tooling- turning tool geometry, milling tooling system, tool presetting, work holding devices **CNC PROGRAMMING**: Steps involved in development of a part program, Manual part programming for turning, milling and drilling operations.		**08 Hours**
Modules-III		
PRODUCTION: Types of Production, Job shop production, Batch production, Mass production, Functions in Manufacturing, Processing, Assembly, Material handling and storage, Inspection and test, Control, **AUTOMATED FLOW LINE**: Automation Definition, Types of Automation, Fixed automation, Programmable automation, Flexible automation, Reasons for Automation, Automation Strategies,		**08 Hours**
Modules-IV		
MATERIAL HANDLING AND STORAGE: Material handling functions, overview of metal handling equipment, Material handling analysis, Design of system, conveyor system, automated guided vehicle system, automated storage/ retrieval systems, carousel storage systems, Work in process storage.		**08 Hours**

Modules-V	
COMPUTERIZED MANUFACTURING PLANNING SYSTEM: Computer-aided process planning: retrieval and generative type, material requirement planning, Capacity planning, Group technology: part family, parts classification and coding system. **COMPUTER AIDED QUALITY CONTROL**: Inspection methods, non-contact inspection methods, machine vision system, optical inspection method, coordinate measuring machine, computer aided testing.	**09 Hours**

Question paper pattern:

1. Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
2. Five full questions are to be answered selecting at least One full question from Each Module.
3. Each question should not have more than 4 sub divisions

Text books:

1 Automation, Production Systems and Computer-Integrated Manufacturing. Mikell P Groover 4th Edition,2015.
2 CAD / CAM Principles and Applications P N Rao Tata McGraw-Hill 3rd Edition, 2015.
3 CAD/CAM/CIM Dr. P. Radhakrishnan New Age International Publishers, New Delhi. 3rd edition

Reference Books:

1 . CAD/CAM -zimmers & grover-PHL
2. CAD/CAM zeild-Mc-Graw Hill-2005.

E books and online course materials:

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21AU713	**CO1**	Explore the significance of CIM in manufacturing and analysis.
	CO2	Outline the concept of CNC and be able to create part programs for simple jobs
	CO3	Review various transfer mechanisms, and analyse automated flow lines.
	CO4	Identify various material handling, storage systems
	CO5	Recognize contemporary manufacturing trends such as CAPP, GT, and CAQC.

Professional Elective – III

Course Title: **VEHICLE BODY ENGINEERING AND EARTH MOVING EQUIPMENTS**		
Course Code	**21AU721**	CIE: 50
Number of Lecture Hours/Week	3 (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules		**Teaching Hours**
MODULE - I		
VEHICLE BODY DETAILS AND MATERIALS: Types: Saloon, Convertibles, Limousine, Estate Van, Racing and Sports car. Bus Types: Mini bus, single decker, double decker, two level, split level and articulated bus - Bus body layout, Floor height, Engine location, Entrance and exit location, seating dimensions, constructional details		**8 Hours**
MODULE - II		
VEHICLE VISIBILITY AND SAFETY: Visibility: regulations, driver's visibility, tests for visibility - Methods of improving visibility and space in cars, Safety: safety design. Safety equipment's for cars. Car body construction. Dimensions of driver's seat relation to controls Driver's cab design		**8 Hours**
MODULE - III		
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,		**9 Hours**

MODULE - IV .	
EARTH MOVING MACHINES: Bulldozers, cable and hydraulic dozers. Crawler track, Loaders, single bucket, multi bucket and rotary types. **SCRAPERS AND GRADERS:** Scrapers, elevating graders, self-powered scrapers and graders. **SHOVELS:** Power shovel, revolving and stripper shovels - draglines - ditchers Capacity of shovels. **HYDRAULICS:** Basic components of hydraulic systems like pumps, control valves, relief valves and hydraulic motors and hydraulic cylinders.	**9 Hours**
MODULE - V	
HAULING EQUIPMENTS: **TRACTORS AND DUMPERS:** Classification of tractors, safety rules, working attachment of tractors, farm equipment classification auxiliary equipment's – trailers and body. **DUMPERS**: capacity, operation, preventive Maintenance, production estimates, equipment trailers**.**	**8 Hours**
Question paper pattern: 1. Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus. 2. Five full questions are to be answered selecting at least One full question from each Module. 3. Each question should not have more than 4 sub divisions	
Reference Books: 1. Giles.J.C. " Body construction and design ", lliffe Books Butterworth & Co., 1971 **2.** John Fenton, " Vehicle Body layout and analysis ", Mechanical Engg Publication Ltd., London, 1982. **3.** Braithwaite.J.B., " Vehicle Body building and drawing ", Heinemann Educational Books Ltd., London, 1977. **4.** Sydney.F.Page 5. 1. Abrosimov. K. Bran berg.A. and Katayer.K., "Road making Machinery ", MIR Publishers, Moscow, 1971. 6. Wang.J.T., "Theory of Grand vehicles ", John Wiley & Sons, New York, 1987. 7. Off the road wheeled and combined traction devices - Ashgate Publishing Co. Ltd. 1998.	

8. Tractors and their power units by John B LIIzedaw et-al

E books and online course materials:

1. https://www.slideshare.net/rafiyaparveen1994/earth-moving-equipments-55235550
2. www.earthmovers-magazine.com.au/
3. https://www.nbmcw.com/...material.../35838-sany-material-handling-earth-moving-eq..
4. www.visualdictionaryonline.com/transport-machinery/heavy-machinery.php

Course outcomes:

On completion of the course, the student will have the ability to:

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Course Code	CO #	Course Outcome (CO)
21AU721	**CO1**	Identify the concepts of vehicle body construction and materials used.
	CO2	Expose students to international safety and visibility standards in cars.
	CO3	Illustrate the concepts of vehicle aerodynamics in passenger cars.
	CO4	Recognize different earth moving equipment's and their operations.
	CO5	Identify heavy earth hauling vehicles and their operational characteristics.

Course Title: **CRYOGENICS**				
Subject Code	21AU722	Credits	03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)			SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03
Modules				**TeachingHours**
MODULE-I				
INTRODUCTION TO CRYOGENIC SYSTEMS: Cryogenic propellants and its applications, liquid hydrogen, liquid nitrogen, and liquid Helium. The thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion. **GAS LIQUEFACTION SYSTEMS:** Liquefaction systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems.				**08 Hours**
MODULE-II				
GAS CYCLE CRYOGENIC REFRIGERATION SYSTEMS: Classification of Cryo coolers, Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt's analysis of Stirling cycle, Various configurations of Stirling cycle refrigerators, Integral piston Stirling cryo-cooler, Free displacer split type Stirling Cryo coolers, Gifford McMahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators.				**08 Hours**
MODULE-III				
Gas Separation and Gas Purification Systems: Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems. **Ultra Low Temperature Cryo – Refrigerators:** Magneto Caloric Refrigerator 3He-4He Dilution refrigerator. Pomeranchuk cooling. Measurement systems for low temperatures, Temperature measurement at low temperatures, Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry. Liquid level sensors.				**08 Hours**

MODULE-IV	
VACUUM TECHNOLOGY: Vacuum Technology: Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation	**08 Hours**
MODULE-V	
CRYOGENIC FLUID STORAGE AND TRANSFER SYSTEMS: Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines. Cryogenic fluid transfer, External pressurization, Self-pressurization, Transfer pump. **APPLICATION OF CRYOGENIC SYSTEMS:** Cryogenic application for food preservation – Instant Quick-Freezing Techniques Super conductive devices, Cryogenic applications for space technology. Application of cryogenic systems, super conducting devices, space technology, cryogenic in biology and medicine.	**10 Hours**

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Cryogenic Systems – R.F. Barron
2. Cryogenic Engineering – R.B. Scott – D.VanNostrand Company, 1959

Reference Books:

1. Cryogenic Process Engineering – K.D. Timmerhaus and T.M. Flynn, Plenum Press, New York,1989
2. High Vacuum Technology – A. Guthree – New Age International Publication
3. Experimental Techniques in Low Temperature Physics – G.K. White – Osford University Press,

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

	CO	Course Outcome (CO)
	CO1	Explore cryogenic and gas liquification systems.

	CO2	Be fully conversant with cryogenic refrigeration systems
	CO3	Be qualified to design systems for gas separation and purification
	CO4	Identify and solve the problem in insulation, storage of cryogenic liquids
	CO5	To conduct cryogenic research and use cryogenics in a variety of applications

Course Title: **FLEXIBLE MANUFACTURING SYSTEMS**				
Subject Code	21AU723	Credits	03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)			SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03
Modules				**Teaching Hours**
MODULE-I				
INTRODUCTION: - Definition, Basic components of FMS, Levels of manufacturing flexibility, Different types of FMS, FMS Layout configurations, Objectives of FMS, Advantages and disadvantages of FMS.FMS Planning and Design Issues and operational issues.				**08 Hours**
MODULE-II				
MANUFACTURING CELL: - Introduction, classification of cell, Unattended machining,Differences between FMC AND FMS. **MACHINING CENTERS**: - Introduction to machining centres, classification, numerical control machining centres, NC Turning centre. Deburring, types of Automated Deburring, wash stations, classification of wash stations.				**09 Hours**
MODULE-III				
INDUSTRIAL ROBOTICS: - Robot anatomy, Robot control systems, sensors in robotics,industrial robot applications. **CUTTING TOOLS AND TOOL MANAGEMENT**: - Introduction to cutting tools, control of cutting tools, Role of Tool management in FMS, Tool monitoring and fault detection.				**09 Hours**
MODULE-IV				
FMS SYSTEM HARDWARE AND SOFTWARE STRUCTURE: - General structure and requirements, Introduction to PLC, components of PLC and PLC programming. FMS installation and implementation, acceptance testing.				**08 Hours**
MODULE-V				

JIT AND KANBAN SYSTEM: - Lean production system, Introduction to Just-in-Time (JIT) Production system, Goals of JIT, Benefits of JIT, Principal Objectives of JIT, Error Prevention, Introduction to Kanban system, types of Kanban.	**08 Hours**

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1.Shivanand H.K., Benal MM, Koti V, "Flexible Manufacturing System", New age international(P)Limited, New Delhi, 2006

Reference Books:

1. Mikell P. Groover "Automation, Production Systems and Computer Integrated Manufacturing",PHI, 2008.
2. Kalpakjin, "Manufacturing Engineering and Technology ", Addison Wesley Publishing Co., 1995.

Course outcomes:

On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	Analyse the role of FMS in manufacturing systems.
CO2	Elucidate the concept of NC machining centres and Automated Deburring operations.
CO3	Role of Industrial robotics in manufacturing systems and tool management.
CO4	Recognize various FMS Hardware and software systems.
CO5	Interpret the importance JIT methods in Manufacturing systems.

Open Elective - II

Course Title: **NON- CONVENTIONAL ENERGY SOURCES**		
Course Code	21AU73OE1	CIE: 50
Number of Lecture Hours/Week	3 (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules		**Teaching Hours**
Module-I		
INTRODUCTION TO ENERGY SOURCES: Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. **SOLAR ENERGY:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length, **SOLAR THERMAL SYSTEMS:** Flat plate collectors, concentrating collectors, advantages and disadvantages of concentrating collectors over flat plate type collectors		**09 Hours**
Module-II		
STORAGE OF SOLAR ENERGY: Thermal storage, solar pond, solar water heaters, solar distillation. **SOLAR PHOTO-VOLTAIC**: Solar Cell Principle, Semiconductor Junctions, Conversion efficiency and power output, Basic Photo Voltaic System for Power Generation. **WIND ENERGY:** Principle of wind energy conversion – nature of the wind, the power in the wind, forces on the blades, wind energy conversion; wind data and energy estimation, Site selection considerations, basic components of wind energy conversion systems (WECS); classification of WECS, advantages and disadvantages of WECS.		**09 Hours**

Module-III	
BIOMASS: Biomass conversion technologies, photosynthesis, Biogas generation plants, Factors affecting bio-digestion, classification, advantages and disadvantages of floating drum plant and fixed dome plant, problems related to bio gas plants, fuel properties and utilization of bio-gas, biomass as a source of energy, thermal gasification of biomass.	**08 Hours**
Module-IV	
HYDROGEN ENERGY AND FUEL CELL: Introduction, Hydrogen production, electrolysis, thermo-chemical methods; hydrogen storage, transportation, utilization. **FUEL CELLS**: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics.	**08 Hours**
Module-V	
GEOTHERMAL ENERGY: Applications, Origin and distribution of Geothermal Energy, Types of Geothermal resources, Exploration and development of Geothermal Resources, Environmental Consideration, Geothermal Energy in India **OCEAN ENERGY**: Tidal Energy -Principle of working, performance and limitations. Wave Energy Principle of working, performance and limitations. Ocean Thermal Energy - Availability, theory and working principle, performance and limitations.	**08 Hours**
Course outcomes: After studying this course, students will be able to: CO1: Explain need of renewable energy sources; analyse solar geometry and solar energy and its measurement. CO2: Illustrate principle of operation of solar energy systems and storage. CO3: Estimate power in wind energy and describe wind energy conversion systems. CO4: Identify and outline biomass energy, production of biogas and biomass gasification. CO5: Explain emerging technologies such as hydrogen energy, fuel cell, Geothermal Energy and ocean energy.	
Question paper pattern: Two questions from each module to be set and students have to answer one question from each module	
Text books: 1. G D Rai, Non- conventional sources of energy, Khanna Publishers, New Delhi, 2005 2. P S Sukhatme, Solar Energy, 2nd Edition, Tata McGraw Hill Publications	

Reference Books:

1. Alternative Energy Sources - B.L. Singhal - Tech Max Publication
2. M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional "
BSP Publications,2006.
3. D.S. Chauhan," Non-conventional Energy Resources" New Age International
4. Solar Engineering of Thermal Processes by Duffic and Beckman, John Wiley John
5. Twidel and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006

E books and online course materials:

1. **https://nptel.ac.in/courses/121106014/**
2. **https://onlinecourses.nptel.ac.in/noc18_ge09/preview**
3. **https://gctbooks.files.wordpress.com/2016/02/renewable-energy-resources-by-john-twidell-tony-weir.pdf**

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21AU73OE	**CO1**	Explain need of renewable energy sources; analyse solar geometry and solar energy and its measurement.
	CO2	Illustrate principle of operation of solar energy systems and storage.
	CO3	Estimate power in wind energy and describe wind energy conversion systems.
	CO4	Identify and outline biomass energy, production of biogas and biomass gasification.
	CO5	Explain emerging technologies such as hydrogen energy, fuel cell, Geothermal Energy and ocean energy.

Course Title: **AUTOMOTIVE POLLUTION AND CONTROL**		
Course Code	**21AU73OE2**	CIE: 50
Number of Lecture Hours/Week	3 (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules		**Teaching Hours**
Module -I		
INTRODUCTION: Pollutants - sources - formation - effects – transient operational effects on pollution. **INFLUENCE OF FUEL PROPERTIES**: Effect of petrol, Diesel Fuel, Alternative Fuels and lubricants on emissions.		**7 Hours**
Module -II		
SI ENGINE COMBUSTION AND POLLUTANT FORMATION: Chemistry of SI engine combustion - HC and CO formation in 4- stoke and 2-stroke SI engines - NO formation in SI engines - Particulate emissions from SI engines - Effects of operating variables on emission formation.		**9 Hours**
Module -III		
CI ENGINE COMBUSTION AND EMISSIONS: Basics of diesel combustion, diesel spray, Smoke emission in diesel engines - NO emission from diesel engines– Particulate emission in diesel engines. Effects of operating variables on emission formation. Diesel trap oxidizers.		**9 Hours**
Module -IV		
CONTROL TECHNIQUES FOR SI AND CI ENGINE EMISSION REDUCTION: Design changes - Optimization of operating factors– NO emission control techniques, Fumigation - Air injection PCV system - Exhaust treatment in SI engines - Thermal reactors - Catalytic converters - Catalysts - Use of unleaded petrol.		**9 Hours**
Module -V		
MEASUREMENT & INSTRUMENTATION FOR EMISSION: Test procedures - NDIR analyser - Flame ionization detectors – Chemiluminescent analyser – Gas chromatograph – Smoke meters - Emission - standards. Measurement evaporative emissions **LAWS AND REGULATION –** Regulatory test procedures – American driving cycles, European cycles, Japanese cycles.		**8 Hours**

Question paper pattern:

1. Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
2. Five full questions are to be answered selecting at least One full question from each Module.
3. Each question should not have more than 4 sub divisions

Text books: Text Books:

1. Engine Emission -Springer and Patterson, Plenum Press, 1990.
2. Automobiles and Pollution - Paul Degobert (SAE)
3. Internal combustion engine fundamentals – John B. Heywood, McGraw-Hill, 1998

Reference Books:

1. Ganesan.V., "Internal Combustion Engines ", Tata McGraw Hill Co., 1994.
2. SAE Transactions, "Vehicle emission ", 1982 (3 volumes).
3. Obert.E.F., "Internal Combustion Engines ", 1982.
4. Taylor.C.F., "Internal Combustion Engines ", MIT Press, 1972.

E books and online course materials:

https://www.ncbi.nlm.nih.gov/books/NBK218144/

https://www.tandfonline.com/doi/pdf/10.1080/00022470.1963.10468138

https://www.tandfonline.com/doi/pdf/10.1080/00966665.1958.10467845

https://www.diva-portal.org/smash/get/diva2:1155571/FULLTEXT02.pdf

https://www.technicalsymposium.com/alllecturenotes_auto.html

Course outcomes:

On completion of the course, the student will have the ability to:

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Course Code	CO #	Course Outcome (CO)
21AU742	**CO1**	Explain pollutants emitted by engines and their effects on environment and human health.
	CO2	Emission formation in SI and CI Engines.
	CO3	Identify the effect of fuel properties on emission and use of alternate fuels.
	CO4	Analyse the concepts of control techniques in emission in IC Engines.
	CO5	Explain principles of working of pollution measuring instruments.

Open Elective – III

Course Title: **TRANSPORT MANAGEMENT AND ECONOMICS**		
Course Code	**21AU74OE1**	CIE: 50
Number of Lecture Hours/Week	3 (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules		**Teaching Hours**
MODULE – I		
ADMINISTRATIVE ORGANIZATION: Principal function of administrative, traffic, secretarial and engineering divisions, chain of responsibility, forms of ownership, Drivers and conductors' duties, training and recruitment of drivers and conductors, factors affecting punctuality of service. **ROUTE PLANNING:** Sources of traffic, town planning, turning points, stopping places, shelters, survey of route, preliminary schedule, test runs, elimination of hazards, factors affecting frequency, direction of traffic flow, community of interest, estimating traffic volume, estimated number of passengers, estimated traffic possibilities, single verses double Deckers.		**09 Hours**
MODULE – II		
TIMING, BUS WORKING AND SCHEDULES: Time table layout, uses of flat graph method of presentation, Preparation of vehicle and crew schedules, preparation of duty roster, co-operation with employers, use of vehicle running numbers, determination of vehicle efficiency, checking efficiency of crew duty arrangements. **GARAGES AND BUS STATIONS:** Bus garages, requirements, layout of premises, size, function, location, design, equipment, use of machinery, garage organization, large scale overhaul system, requirement of facilities at depot legal provisions for depot, layouts. Bus stations: drive through type, head on type, facilities for passengers.		**09 Hours**
MODULE - III		

FARE COLLECTION SYSTEMS: Need, Principles of fare collection the way bill, different types of fare collection systems, pre-printed denomination ticket, scribe/ hand written ticket, card ticket, advance booking/reservation, machine ticket, box system, personal and common stock **THE FARES' STRUCTURE:** Basis of fares, historical background, stage, designing of stage, straight and tapered scale, flat fare, zonal fare, concession fares, charges for workmen, attracting traffic, compilation of fare table, anomalies, double booking, inter-availability, through booking and summation, private hire charges.	**08 Hours**
MODULE – IV	
PUBLIC RELATIONS WORK AND PREVENTION OF ACCIDENTS: Dissemination of information, maintaining goodwill, handling complaints, traffic advisory committees, local contact, cooperation with press, news and articles, facilities for visitors, forms of publicity, importance of quality, inter departmental liaison, advertisements, signs, notices and directions, general appearance of premises, specialized publicity. **PREVENTION OF ACCIDENTS:** Emphasis of safe driving, annual awards, bonus encouragement, vehicle design, platform layout, location of stops, scheduled speed, route hazards, records, elimination of accident-prone drivers. **MOTOR VEHICLE ACT**: Schedules and sections –Traffic signs and signals, Registration of motor vehicles - Licensing of drivers – Control of permits - Limits of speed - Constructional regulations.	**08 Hours**
MODULE - V	
DEPRECIATION: Need for depreciation causes of depreciation life and salvage value methods of depreciation. **COSTS:** Standard costs estimated cost, first cost, fixed cost, Variable costs, Incremental cost, Differential cost, Sunk and marginal cost, Breakeven and minimum cost analysis, simple numerical problems.	**08 Hours**

Question paper pattern:

1. Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.
2. Five full questions are to be answered selecting at least One full question from Each Module.
3. Each question should not have more than 4 sub divisions

Text books:

1. Kitchin.L.D., Bus Operation - Iliffe and Sons Ltd., London, III edition
2. Bus and coach operation, Rex W.Faulks, Butterworth version of 1987, London
3. M.V.ACT 1988, Govt Publication.
4. Engineering Economy - TARACHAND, Nem Chand and Brothers, Roorkee
5. Mechanical Estimating and Costing, T. R. Banga and S. C. Sharma, Khanna Publishers, Delhi
6. Panneerselvam, R. *Engineering economics*. PHI Learning Pvt. Ltd., 2013.

Reference Books:

1. John Duke, Fleet Management - McGraw-Hill Co, USA -1984.
2. Industrial Engineering and Management - O.P KHANNA, Dhanpat Rai & Sons.
3. Engineering Economy, Thuesen, G. J. and Fabrycky, W. J., Prentice Hall of India Pvt. Ltd.

E books and online course materials:

https://www.indiacode.nic.in/bitstream/123456789/9460/1/a1988-59.pdf

https://www.academia.edu/35775332/Engineering_Economics_by_Panneer_Selvam_pdf

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21AU74OE	**CO1**	Describe the administrative organization of road transport undertaking and role & responsibilities of different sections
	CO2	Identify and make planning of new route, prepare vehicles and crew schedule.
	CO3	Explain and select the different fare fixation and fare collection methods
	CO4	Describe infra structure facilities to be provided in a road transport undertaking
	CO5	Analyse causes of accidents and methods to prevent accidents; analysis of depreciation & cost and explain the MV act

Course Title: **HYBRID & ELECTRIC VEHICLES**		
Course Code	**21AU74OE2**	CIE: 50
Number of Lecture Hours/Week	3 (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules		**Teaching Hours**
Module-I		
ELECTRIC VEHICLES: Architecture of an electric vehicle, essentials and performance of electric vehicles –Traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations.		**09 Hours**
Module-II		
HYBRID VEHICLES: Hybrid electric drivetrains -Concepts, architecture, design, control strategies, merits and demerits.		**09 Hours**
Module-III		
ELECTRIC PROPULSION SYSTEMS: DC motor drives, induction motor drives, permanent magnet motor drives and switched reluctance motor drives.		**08 Hours**
Module-IV		
ENERGY STORAGE DEVICES: Electrochemical batteries –Reactions, thermodynamic voltage, lead-acid batteries, nickel-based batteries, lithium-based batteries, Super-capacitors, Battery management systems.		**08 Hours**
Module-V		
FUEL CELL AND SOLAR POWERED VEHICLES: Operating principle, fuel cell technologies. **POWER ELECTRONIC CONVERTER FOR BATTERY CHARGING:** Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional.		**08 Hours**
Question paper pattern: Two questions from each module to be set and students have to answer one question from each module		
Text books: 1. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009. 2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011.		
Reference Books: 1. Seref Soylu "Electric Vehicles -The Benefits and Barriers", In Tech Publishers, Croatia, 2011. 2. Aulice Scibioh		

M. and Viswanathan B., "Fuel Cells –Principles and Applications", University Press, India, 2006. 3. Barbir F., "PEM Fuel Cells: Theory and Practice" Elsevier, Burlington, 2005. 4. James Larminie and John Loury, "Electric Vehicle Technology-Explained", John Wiley & Sons Ltd., 2003.

E books and online course materials:

1. **http://ceb.ac.in/knowledge-center/E-BOOKS/Modern%20Electric%2C%20Hybrid%20Electric%20%26%20Fuel%20Cell%20Vehicles%20-%20Mehrdad%20Ehsani.pdf**
2. **https://nptel.ac.in/courses/108/102/108102121/**
3. **https://nptel.ac.in/courses/108/106/108106170/**

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21AU732	**CO1**	Analyse the challenges of electric vehicle over conventional IC engine powered vehicles.
	CO2	Apply the degree of hybridization and alternate power train architectures for a conventional system.
	CO3	Evaluate the characteristics and maximum power demand of electric and hybrid drive propulsion system.
	CO4	Analyse the performance and characteristics of battery and electronics converters for the vehicle propulsion systems.
	CO5	Analyse the performance and characteristics of fuel cell for the vehicle Propulsion system.

Course Title: **PROJECT WORK**				
Subject Code	21AUP751	Credits	10	CIE: 50
Number of Lecture Hours/Week	3 (Practical)			SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03

Prerequisite: Project Work

Course Objectives:

The students should be able to apply acquired knowledge of courses studied in engineering to identify, formulate, analyse, evaluate and provide solution to a technical problem in the field of Automobile Engineering

Modules	**Teaching Hours**

SCHEME OF EVALUATION

Assessment	Marks
CIE I Evaluation (7^{th} week)	25
CIE II Evaluation (12^{th} week)	25
SEE	50
Total	100

Conduct of Project Viva Voce: SEE

- Students should write brief description about the project
- Students should present and demonstrate the project
- Students should clarify and clear all the doubts asked by the examiner

Course outcomes:
On completion of the course, the student will have the ability to:

	CO #	Course Outcome (CO)
	CO1	Identify a problem from the available literature and societal needs.
	CO2	Apply principles of Automobile engineering in designing and conducting experiments, date acquisition and interpretation towards meaningful analysis of identified problem.
	CO3	Use their analytical, teamwork and leadership skills in designing and development ofproducts and find solution
	CO4	Apply advanced tools / techniques for solving the problem.
	CO5	Prepare a detailed quality project report and present the work.

Course Title: **TECHNICAL SEMINAR**				
Subject Code	21AUS81	Credits	01	CIE: 100
Number of Lecture Hours/Week	2 (Practical)			SEE: 00
Total Number of Lecture Hours				
Prerequisite:				

Course Objectives: A Seminar should be given by an individual student based on topics chosen from the emerging areas and technologies of Automobile Engineering Applications. References from journals, articles published by industry etc., shall be used. A report on this seminar with 15-20 pages shall also be Prepared	
Modules	**Teaching Hours**
Suggested Evaluation Guidelines: I. The Head of the Department shall make arrangements for the conduct of seminars through a committee of faculty members of the Department. The committee, constituted for the purpose by the Head of the Department, shall award the CIE marks for the seminar. The committee shall consist of three senior faculty members of the Department and the most senior among them shall be the Chairperson. II. The marks awarded for Seminar shall be based on the evaluation of the Seminar Report, Presentation skill, and Viva-voce (Question & Answers session) in the ratio of 50: 25:25. III. Split up Marks to be assessed is follows: (i) Report marks to be allotted by the seminar guide/s (50 % of the maximum marks) a). Formatting of the report (10% of maximum marks) b). Literature survey (20% of maximum Marks) and c). Technical content of the report (20% of maximum marks) (ii) Seminar Presentation skill marks to be allotted by the committee: (25% of the maximum marks) (iii) Viva—Voce marks to be allotted by the committee: (25% of the maximum marks) a). Understanding of fundamentals and concepts (15%) b). Clarity in answering the questions (10%)	

Course outcomes:
On completion of the course, the student will have the ability to:

	CO #	Course Outcome (CO)
	CO1	Identify current trends in specific area of interest.
	CO2	Perform literature survey related to the specific topics of interest.
	CO3	Analyze the results of technical work

CO4	Write technical reports.
CO5	Summarize and present the technical contents.

Course Title: **RESEARCH/INDUSTRY INTERNSHIP**				
Subject Code	21AUI82	Credits	01	CIE: 100
Number of Lecture Hours/Week				SEE: 100
Total Number of Lecture Hours				SEE Hours: 03
Prerequisite:				

Course Objectives: The internship is an extended period of work experience undertaken by the students aspiring to supplement their degree with professional development. The students are allowed to prepare themselves for the workplace and develop practical skills. The Internship shal1 be completed during the period specified in the Scheme of Teaching and Evaluation. With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship in their home town (within or outside the state or abroad), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. Institute shall not bear any cost involved in carrying out the internship by students. Individual student must carry out Internship training at industry. Student shall submit a detailed report on internship work in a format as specified by the department.	
Modules	**Teaching Hours**
Suggested Evaluation Guidelines: I) The Internship shall be taken up during the period specified in the Scheme of Teaching and Examinations. The Department/ College shall nominate faculty member/s to facilitate, Guide, and supervise students under an internship. The students shall report the progress of the internship to the Guide in regular intervals and seek his/her advice. The Guide shall maintain the progress record of the candidate's undergoing internship. Duration of the internship shall be as mentioned in the scheme of Teaching and Examination. The Internship examination shall be conducted at the end of the internship period II) Report Evaluation: Internship shall be evaluated for 50% maximum marks. The split-up of marks suggested for report evaluation shall be based on, a) Report formatting (20% of marks of CIE for report) b) Presentation of the outcomes in the report (40% of marks for CIE for report) and c)Technical content of the report (40% of marks for CIE for report) Weightage shall be given for paper publication in reputed journals/refereed journals/ Conferences/Product developed/ Patent filed — only for Industry/ Research Internship. III) Viva-Voce shall be conducted for 50% of marks of CIE. The split-up of marks suggested are: a) For demonstration of (soft) skills/Engineering Knowledge gained (50% of marks of CIE for Viva-voce). b) The question-answer session will check for the understanding of the fundamentals and concepts (40% of CIE marks for Viva-voce) c) Clarity in answering the questions (10% of CIE marks for Viva-voce) Viva-voce	

shall be conducted by the Mentor/Guide and Head of the Department/ one of the senior faculty assigned by the Head of the Department.	

Course outcomes:
On completion of the course, the student will have the ability to:

	CO #	Course Outcome (CO)
	CO1	Exposure to industry environment.
	CO2	Identify tools and technology for implementing real world problems.
	CO3	Select appropriate tools for solving problems.
	CO4	Develop communication, inter-personality, and critical skills.