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

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE & SYLLABUS
M.Tech ME for AUTOMOBILE ENGINEERING Programme
(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

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

I -SEMESTER

S.No	Code	Subject		L	T	P	Credits
1	AE 101(Core-1)	Automotive Engineering		3	0	0	3
2	AE102(Core-2)	Computational Fluid Dynamics		3	0	0	3
3	Program Elective – I AE 103	AE 1031	Combustion and Emissions Control	3	0	0	3
		AE 1032	Analysis and Synthesis of Mechanisms				
		AE 1033	Computer Aided Design				
		AE 1034	Automotive Chassis Design				
4	Program Elective – II AE 104	AE 1041	Automotive Electronics	3	0	0	3
		AE 1042	Fluid Power Systems				
		AE 1043	Design of Transmission Systems				
		AE 1044	Automotive Aerodynamics				
		AE 1045	Advanced I.C.Engine, Electric and Hybrid Vehicles				
5	AE 105	Computational Fluid Dynamics Lab		0	0	3	2
6	AE 106	Thermal Engineering Lab		0	0	3	2
7	AE 107	Research Methodology and IPR		2	0	0	2
8	AE 108	Soft Skills		2	0	0	0
Total							**18**

II – SEMESTER

S. No	Code	Subject		L	T	P	Credits
1	AE 201(Core-1)	Vehicle Body Engineering		3	0	0	3
2	AE 202(Core-2)	Vehicle Dynamics		3	0	0	3
3	Program Elective– III AE 203	AE 2031	Noise, Vibrations and Harshness	0	0	3	3
		AE 2032	Condition Monitoring				
		AE 2033	Automotive Air-Conditioning Systems				
		AE 2034	Automotive System Components Design				
4	Program Elective– IV AE 204	AE 2041	Advanced Metal Forming	0	0	3	3
		AE 2042	Automotive Safety and Maintenance				
		AE 2043	Advanced Finite Element Methods				
		AE 2044	Vehicle Control Systems				
		AE 2045	Simulation of Vehicle Systems				
5	AE 205	Modeling and Simulation Lab		0	0	3	2
6	AE 206	Automotive Systems Lab		0	0	3	2
7	AE 207	Mini Project with Seminar		2	0	0	2
8	AE 208	Value Education		2	0	0	0
				Total			18

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

III-SEMESTER

S. No		Subject			L	T	P	Credits
1	Program Elective– V 301	AE 3011	Vehicle Testing and Instrumentation	(OR) MOOCS/ NPTEL certification courses	3	0	0	3
		AE 3012	Engine Management Systems					
		AE 3013	Design and Analysis of Experiments					
		AE 3014	Special Types of Vehicles					
		AE 3015	Composite Materials and Structures					
2	Open Elective AE 302	Students are advised to opt for an open elective course of their choice being offered by other Departments of the Institute (OR) MOOCS/NPTEL certification courses duly approved by the Department			3	0	0	3
3	AE 303	Dissertation phase –I			0	0	20	10
				Total				16

IV-SEMESTER

S. No	Subject	L	T	P	Credits
1	Dissertation phase –II	0	0	32	16

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

I Year - I Semester		L	T	P	C
		3	0	0	3
AUTOMOTIVE ENGINEERING					

UNIT-I:
Introduction: Overview of the course, Examination and Evaluation patterns, History of Automobiles, Classification of Automobiles.
Power Plant: Classification, Engine Terminology, firing order, Hybrid power sources.

UNIT-II:
Lubricating system and cooling systems: Functions & properties of lubricants, methods of lubrication-splash type, pressure type, dry sump, and wet sump & mist lubrication. Oil filters, oil pumps, oil coolers. Characteristics of an effective cooling system, types of cooling system, radiator, thermostat, air cooling & water cooling.

UNIT-III:
Transmission, axles, clutches, propeller shafts and differential: Types of gear boxes, functions and types of front and rear axles, types and functions, components of the clutches, fluid couplings, design considerations of Hotchkiss drive torque tube drive, function and parts of differential and traction control.
Steering System: functions of steering mechanism, steering gear box types, wheel geometry, power steering systems.

UNIT-IV:
Braking and suspension system: functions and types of brakes, operation and principle of brakes, constructional and operation of ABS, classification of brakes
Types of springs shock observers, objectives and types of suspension system, rear axles suspension, electronic control and proactive suspension system.

UNIT-V:
Wheels and tyres: Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications.
Air-conditioning and Lighting system in automobile: A.C System, Voltage regulator, battery and lighting system.

Text Books:
1.Joseph Heitner, Automotive Mechanics, …, CBS publications
2.Srinivasan.S, Automotive Mechanics, 2nd Edition, Tata McGraw-Hill, 2003
Reference Books:
1. Crouse and Anglin, Automotive Mechanism, 9th Edition. Tata McGraw-Hill, 2003.
2. Jack Erjavec, A Systems Approach to Automotive Technology, Cengage Learning Pub., 2009.

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

I Year - I Semester		L	T	P	C
		3	0	0	3
COMPUTATIONAL FLUID DYNAMICS					

UNIT – I

INTRODUCTION: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

SOLUTION METHODS: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

Parabolic equations, explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT – II

HYPERBOLIC EQUATIONS: Explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations.

Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT – III

FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

TREATMENT OF COMPRESSIBLE FLOWS: Potential equation, Eluer equations, Navier-Stokes system of equations, flow-field, dependent variation methods, boundary conditions.

UNIT – IV

FINITE VOLUME METHOD: Finite volume method via finite difference method, formulations for two and three, dimensional problems.

UNIT – V

STANDARD VARIATIONAL METHODS: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOKS:

1. Computational fluid dynamics, T. J.Chung, Cambridge University press,2002.
2. Computational Fluid Dynamics by John D. Anderson, McGraw Hill Book Company 2017.

REFERENCE:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985.
2. Computational Techniques for Fluid Dynamics, Volume 1& 2 By C. A. J. Fletcher, Springer Publication, 2012

I Year - I Semester		L	T	P	C
		3	0	0	3
COMBUSTION AND EMISSION CONTROL					

Unit-I

Combustion Principles: Combustion – Combustion equations, heat of combustion - Theoretical flame temperature – chemical equilibrium and Dissociation -Theories of Combustion - Flammability Limits - Reaction rates – Laminar and Turbulent Flame Propagation in Engines. Introduction to spray formation and characterization.

Unit-II

Combustion in S.I. Engines: Stages of combustion, normal and abnormal combustion, knocking, Variables affecting Knock, Features and design consideration of combustion chambers. Flame structure and speed, Cyclic variations, Lean burn combustion, Stratified charge combustion systems. Heat release correlations**.**

Combustion in C.I. Engines: Stages of combustion, vaporization of fuel droplets and spray formation, air motion, swirl measurement, knock and engine variables, Features and design considerations of combustion chambers, delay period correlations, heat release correlations, Influence of the injection system on combustion, Direct and indirect injection systems.

Combustion In Gas Turbines. Flame stability, Re-circulation zone and requirements - Combustion chamber configurations, Cooling, Materials.

Unit-III

Pollutant Emissions from IC Engines: Introduction to clean air, Pollutants from SI and CI Engines: Carbon monoxide, UBHCs, Oxides of nitrogen (NO-NO_X) and Particulate Matter. Mechanism of formation of pollutants, Factors affecting pollutant formation. Measurement of engine emissions-instrumentation, Pollution Control Strategies, Emission norms-EURO and Bharat stage norms. Emission.Control measures for SI and CI engines. Effect of emissions on environment and human beings**.**

Unit-IV

Control Techniques for Reduction of Emission: Design modifications – Optimization of operating factors – Fuel modification – Evaporative emission control - Exhaust gas recirculation – SCR – Fumigation – Secondary Air injection – PCV system – Particulate Trap – CCS – Exhaust treatment in SI engines –Thermal reactors – Catalytic converters – Catalysts – Use of unleaded petrol.

Unit-V

Test Procedure, Instrumentation & Emission Measurement: Test Procedures CVS1, CVS3 – Test cycles – IDC – ECE Test cycle – FTP Test cycle – NDIRanalyzer – Flame ionization detectors – Chemiluminescent analyzer – Dilution tunnel – Gas chromatograph – Smoke meters –SHED test.

TEXT BOOKS:

1.B.P. Pundir Engine Combustion and Emission, 2011, Narosa Publishing House
2.Sharma, S. P., Fuels and Combustion, Tata McGraw Hill, New Delhi, 2001.

REFERENCES:

1. John B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book, 1998.
2. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003.
3. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, DhanpatRai Publications Pvt.New Delhi-2, 1993.
4. Obert, E.F., Internal Combustion Engine and Air Pollution, International Text Book Publishers, 1983.
5. Cohen, H, Rogers, G, E.C, and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd., 1980.
6. Mishra, D.P., Introduction to Combustion, Prentice Hall,2009

I Year - I Semester		L	T	P	C
		3	0	0	3
ANALYSIS AND SYNTHESIS OF MECHANISMS					

Unit-I

Introduction: Mechanisms and machines, Planer and Spatial Mechanisms, Mobility, type of motion, links, joints and kinematic chains, of mechanisms, four bar chain, isomers, Linkage transformation, Inversion, four link planar mechanisms, Groshof condition, spring as a link, complaint mechanisms, Practical considerations – pin joints versus sliders.

Position Analysis: Position and systems, co-ordinate transformation, rotation, translation and combined motion, Algebraic position analysis, position any point on a linkage, transmission angles, toggle positions.

Unit-II

Kinematics of Rigid Bodies: Plane Motion of a rigid body, graphical velocity and acceleration analysis, Instantaneous centers of velocity, Centrodes, velocity of rub, Analytical solutions for velocity Analysis – velocity of any point on a linkage, Acceleration of any point on a linkage, Coriolis acceleration. Analytical solutions for velocity and acceleration analysis
- loop closure equations, Case studies – four-bar pin joined linkage, four link slider-crank.

Unit-III

Analytical Linkage Synthesis: Types of kinematic synthesis – Motion and Path generation, Number synthesis, Dimensional synthesis, Two position synthesis for rocker output, Precision Points, Comparison of analytical and graphical two position synthesis, three position synthesis.

Unit-IV

Graphical Linkage Synthesis: Two position synthesis for rocker output, Three position synthesis, Position synthesis for more than three positions (four and six bar quick return), Coupler curves, Exact and approximate straight line mechanisms.

Unit-V

Cam: Terminology, types of follower, follower motions, cams, SVAJ diagrams, law of cam design, Single and Double dwell cam design using SHM, cycloidal displacement, combined functions. Critical path motion, practical design considerations.

Gears and Gear Trains: Law of gearing, involute tooth form, pressure angle, backlash, contact ratio, Interference and method to avoid interference, Gear Train and its analysis.

TEXT BOOKS:

1. Kinematics and Dynamics of machnery, R L. Norton, Pearson, 2009
2. Kinematics Analysis and Synthesis of Mechanisms - A K Mallik, Amitabha Ghosh and Guntur, D. CRC Press, 2011.

REFERENCES:

1.Mechanical Engineering Design - Shigley et al., Tat McGraw Hill, 2011

I Year - I Semester		L	T	P	C
		3	0	0	3
COMPUTER AIDED DESIGN					

Unit-I

Introduction: Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, geometric modelling.

Transformations in Geometric Modeling: Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Computer-Aided assembly of rigid bodies, applications of transformations in design and analysis of mechanisms, etc. Implementation of the transformations using computer codes.

Unit-II

Projections: Projective geometry, transformation matrices for Perspective, Axonometric projections, Orthographic and Oblique projections. Implementation of the projection formulations using computer codes.

Introduction to Geometric Modeling for Design: Introduction to CAGD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling.

Unit-III

Curves in Geometric Modeling for Design: Differential geometry of curves**,** Analytic Curves, PC curve, Ferguson's Cubic Curve, Composite Ferguson, Curve Trimming and Blending. Bezier segments Bernstein polynomials, Composite Bezier. B-spline basis functions, Properties of basic functions, NURBS. Conversion of one form of curve to other. Implementation of the all the curve models using computer codes in an interactive manner.

Unit-IV

Surfaces in Geometric Modeling for Design: Surfaces entities (planar, surface of revolution, lofted etc). Free-form surface models (Hermite, Bezier, B-spline surface). Boundary interpolating surfaces (Coon's). Implementation of the all the surface models using computer codes.

Unit-V

Solids in Geometric Modeling for Design: Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modeling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modeling methods in CAD software. Data Exchange Formats and CAD Applications

TEXT BOOKS:

1. A. Saxena and B. Sahay, Computer-Aided Engineering Design, Anamaya Publishers, New Delhi, 2005.
2. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008.

REFERENCES:

1.Michael E. Mortenson, Geometric Modeling, Tata McGraw Hill, 2013.
2.Rogers, David F., An introduction to NURBS: with historical perspective, Morgan Kaufmann Publishers, USA, 2001.

I Year - I Semester		L	T	P	C
		3	0	0	3
AUTOMOTIVE CHASSIS DESIGN					

UNIT I:

LAYOUT, FRAME, FRONT AXLE AND STEERING SYSTEM: Basic construction of chassis, Types of Chassis layout, with reference to Power Plant location and drive, various, types of frames, Loads acting on vehicle frame, Types of Front Axles and Stub Axles, Front Wheel Geometry. Condition for True Rolling Motion. Ackerman's and Davi's Steering Mechanisms, Steering Linkages, Different Types of Steering Gear boxes, Slip Angle, Over–Steer and Under–Steer, Reversible and Irreversible Steering, Power Steering.

UNIT II:

DRIVE LINE, FINAL DRIVE AND DIFFERENTIAL: Driving Thrust and its effects, torque reactions and side thrust, Hotchkiss drive, torque tube drive, radius rods and stabilizers, Propeller Shaft, Universal Joints, Constant Velocity Universal Joints, Final drive, different types of final drive, Worm and Worm wheel, straight bevel gear, spiral bevel gear and hypoid gear final drive. Differential principle. Constructional details of differential unit, Differential housings, Non–Slip differential, Differential locks.

UNIT III:

REAR AXLES, WHEELS, RIMS AND TYRES: Construction of rear axles, Types of Loads acting on rear axles, Full –Floating, Three–Quarter Floating and Semi–Floating Axles, Twist beam rear axle, Types, Multi axles vehicles. Wheels and Rims, Types of Tyres and their constructional details.

UNIT IV:

SUSPENSION SYSTEM: Requirement of Suspension System, Types of Suspension Springs, Constructional details and characteristics of Single Leaf, Multi–Leaf spring, Coil and Torsion bar Springs, Rubber, Pneumatic and Hydro – elastic Suspension Spring Systems, Independent Suspension System, Shock Absorbers, Types and Constructional details of Leaf and Coil Springs.

UNIT V:

BRAKE SYSTEMS: Need for Brake systems, Stopping Distance, Time and Braking Efficiency, Effect of Weight Transfer during Braking, Classification of brakes , Braking Torque, drum brake and disc Brake Theory, Types and Construction of Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Servo Brakes, Retarders – antilock braking systems(ABS).

TEXT BOOKS:

1. Newton Steeds and Garret, "Motor Vehicles" 13th Edition, Butterworth, London, 2005.
2. Heinz Hazler, "Modern Vehicle Technology", Butterworth, London, 2005.
3. Devaradjane. Dr. G., Dr. M. Kumaresan, "Automobile Engineering", AMK Publishers, 2013.

REFERENCES:

1. Heldt P.M., "Automotive Chassis" Chilton Co., New York, 1990
2. Giri. N.K., "Automotive Mechanics" Khanna Publishers, New Delhi, 2005.
3. Milliken & Milliken, "Race Car Vehicle Dynamics", SAE, 1995

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

I Year - I Semester		L	T	P	C
		3	0	0	3
AUTOMOTIVE ELECTRONICS					

Unit-I

Introduction: Overview of the course, Examination and Evaluation patterns, History of Automotive electronics.

Safety and Communication: Safe working practices-work cloths, eye protection, fire protection, battery safety. Working as an electricity / electronics technician-your toolbox, access to wiring diagrams and repairs information, communicating with the customer, working around air bags

Circuit fundamentals and basic test equipment: voltage, current**,** resistance, circuits components, series and parallel circuits, purpose of voltmeters, measuring voltage drop, connecting the voltmeter, types of ammeters, current probes, reading and interpreting ohmmeter readings, continuity testing.

Vehicle circuits: circuit components, analyzing series and parallel circuits, control circuits, diagnosing open and short circuits.

Digital Storage Oscilloscope: voltage and time setting, DSO trigger and slope, using a current probe with DSO, using the DSO's multiple-trace capability.

Unit-II

Electronic fundamentals: solid state devices, electronic control input devices, diagnosing and servicing electronic control input devices, integrated circuits as input devices, diagnosing and servicing ICs, oxygen sensors, diagnosing and servicing oxygen sensors.

Wiring diagrams and Batteries: wiring diagram symbols, using the wiring diagram as a service tool, automotive batteries, diagnosing batteries, servicing batteries.

Unit-III

Starting and charging systems: starting circuits, solenoid shift starters, diagnosing and servicing solenoid shift starters systems, positive engagement starters, diagnosing and servicing positive engagement starting system, gear-reduction starters, diagnosing gear- reduction starters, charging system overview, field circuits, diagnosing and servicing the charging system.

Unit-IV

Ignition systems and accessories: secondary ignition systems, servicing the secondary ignition system, primary ignition system, diagnosing and servicing distributed primary ignition systems, distributor less ignition secondary circuits, diagnosing and servicing the secondary ignition system on a distributor less vehicles, distributor less ignition primary circuits, diagnosing and servicing the primary circuit on a distributor less ignition system. Lighting circuits, diagnosing lighting circuits, defogger, horn, and windshield wiper circuits, diagnosing defogger, horn, and windshield wiper circuits, motor driven accessories, diagnosing motor driven accessories.

Unit-V

Electronic control units and sensors: Vehicle sensors-speed, temperature, fuel level, battery condition, emissions, feedback circuits.

TEXT BOOKS:

1. Al Santini, Automotive Technology, Electricity and Electronics, Cengage Publishers, 2011.
2. William Ribbens, Understanding Automotive Electronics, 6th Edition, Elsevier, 2011.

I Year - I Semester		L	T	P	C
		3	0	0	3
FLUID POWER SYSTEMS					

Unit-I

Basic components: Introduction, Basic symbols, Merits, Demerits and applications, Pumps, actuators, Valves.

Hydraulic Circuits: Regenerative sequence, Semiautomatic, automatic Speed controls.

Unit-II

Power amplifiers and tracer control systems: Introduction and type of copying systems, Single coordinate parallel tracer control systems, tracer control systems with input pressure, tracer control systems with four edge tracer valve, Static and dynamic copying system, Types of tracer valve.

Unit-III

Design of Hydraulic circuits: Design of hydraulic circuits for various machine tools.

Servo system: Introduction and types, Hydro mechanical servo valve system, Electro hydraulic servo valve system, Introduction and evolution.

Unit-IV

Fluidics: Introduction and evolution, Type of gates and their features, Applications of Fluidics.

Unit-V

Simulation: FPS implementation and analysis.

TEXT BOOKS:

1. Esposito, Fluid power with applications, Pearson, 2011
2. M.Galalrabie, Rabie M "Fluid power Engg." Professional Publishing, 2009
   John J Pippenger and W.Hicks, "Industrial hydraulics" Tata McGraw Hill, 1980

I Year - I Semester		L	T	P	C
		3	0	0	3
DESIGN OF TRANSMISSION SYSTEMS					

Unit-I

Introduction: Introduction to transmission system, classification of transmission systems, Manual, Automatic, transmission used in vehicles, tractive effort.

Manual Transmission: Design of Sliding mesh gear box, constant mesh gear box, synchronous mesh gear box. Gear shift lever mechanism.

Automatic Transmission: Torque convertors, fluid coupling, five speeds and six speed gear box.

Unit-II

Clutch: Principle of operation, friction lining materials, calculation of torque capacity and axial force. Different types of clutches - Dry and Wet type, Design of plate clutches - axial, cone clutches, centrifugal clutch, Design of Axles.

Unit-III

Differential: Straight bevel gear: Tooth terminology, Estimating the dimensions of pair of straight bevel gears.

Unit-IV

Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency.

Unit-V

Flexible Drives: Design of Flat belts and pulleys, selection of V belts, wire ropes and pulleys, stepped pulleys – Design of Transmission chains and Sprockets.

TEXT BOOKS:

1. Norton R.L., Machine Design: An Integrated Approach, 4th Ed. Prentice Hall, 2010.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.
3. U.C.Jindal : Machine Design, "Design of Transmission System", Dorling Kindersley, 2010.
4. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

I Year - I Semester		L	T	P	C
		3	0	0	3
AUTOMOTIVE AERODYNAMICS					

UNIT I

SCOPE OF ROAD VEHICLE AERODYNAMICS

Introduction, Properties of Incompressible Fluids, External Flow Phenomena Related to Vehicles, Aerodynamic Forces and Moments, Resistances to Vehicle Motion, Performance, Fuel Consumption and Fuel Economy, Strategy for Lowest Fuel Consumption.

UNIT II

AIR RESISTANCE ON PASSENGER CARS

Car as a Bluff Body, Drag and Lift, Drag Fractions and Their Local Origins - Front End, Windshield and A-Pillar, Roof, Rear End, Plan View and Side Panels, Underbody, Wheels and Wheel Housings, Front Spoiler, Rear Spoiler. Strategies for Body Shape Development – Objectives, Detail Optimization, Shape Optimization, Facelift, Spoilers.

UNIT III

AERODYNAMIC DRAG ON COMMERCIAL VEHICLES

Relation between Tractive Resistance, Drag Reduction and Fuel Consumption, Aerodynamic Drag Coefficients of Various Commercial Vehicles, Drag Minimization on Trucks, Buses. Add-on devices for drag reduction. Reduction of Vehicle Soiling, Water accumulation on windshield and windows.

UNIT IV

MOTORCYCLE AERODYNAMICS

Development of Motorcycle Aerodynamics, Riding Dynamics and its Relationship with Aerodynamics, Methods of Measurement in Road Tests, Rider Influences - Rider and Pillion Passenger, Clothing and Helmets. Case Studies on racing models.

UNIT V

WIND TUNNELS, MEASUREMENT AND TEST TECHNIQUES

Fundamentals of Wind Tunnel Technique, Tests with Reduced-Scale Models - Details of Model Construction and Test Technique, Reynolds Number Effects, Climatic Tunnels. Measuring Equipment and Transducers – Flow visualization techniques, Measurement of Aerodynamic Forces and Moments, Pressure Measurements, Measurement of the Airflow Velocity, Temperature Measurement

TEXT BOOKS:

1.Hucho. W.H. –"Aerodynamic of Road Vehicles From Fluid Mechanics to Vehicle Engineering" , Society of Automotive Engineers, U.S, Fourth edition.

2.R.H.Barnard - "Road vehicle aerodynamic design, An Introduction" , Mechaero publications, Third edition, 2010

REFERENCES:

1.T. Yomi Obidi - "Theory and Applications of Aerodynamics for Ground Vehicles" , SAE International, 2014

2.Alan Pope, Jewel B. Barlow, William H. Rae "Low speed wind tunnel testing" , John Wiley & Sons, Third edition, 1998

I Year - I Semester		L	T	P	C
		3	0	0	3
ADVANCED I.C ENGINE, ELECTRIC AND HYBRID VECHILES					

UNIT-I:

GAS EXCHANIGING PROCESSES:

Inlet and exhaust processes in the four stroke cycle volumetric efficiency quasi static effects combined quasi static and dynamic effects variation with speed and valve area lift and timing –flow through valves poppet valve geometry and timing flow rate and discharge coefficients, residual gas fraction , exhaust gas flow rate and temperature variation, scavenging in two stroke cyclic engines, scavenging parameters and models actual scavenging processes , flow through ports, super charging and turbo changing – methods of power boosting basic relationships compressors, turbines wave compression devices.

UNIT-II:

CHARGE MOTION WITHIN THE CYLINDER:

Intake Jet Flow, Mean velocity and turbulence characteristics definitions application to engine velocity data swirl – swirl measurement, swirl generation during induction swirl modification within the cylinder squish pre chamber engine flows crevice flows and blowby flows generated by piston – cylinder wall interaction.

UNIT-III:

COMBUSTION IN S.I AND C.I ENGINES:

Review of normal and abnormal combustion in SI and CI engine cyclic variation in combustion of SI engine , analysis of cylindrical pressure data in SI and CI engine ,MPFI in SI engines common rail fuel injection system in CI engines fuel spray behavior in CI engines.

UNIT- IV:

ELECTRIC VEHICLES:

Introduction: Limitations of IC Engines as prime mover, History of EVs, EV system, components of EV-DC and AC electric machines: Introduction and basic structure, Electric vehicle drive train, advantages and limitations, Permanent magnet and switched reluctance motors

BATTERIES: Battery: lead, acid battery, cell discharge and charge operation, construction, advantages of lead, acid battery, Battery parameters: battery capacity, discharge rate, state of charge, state of discharge, depth of discharge, Technical characteristics, Ragone plots.

UNIT- V:

HYBRID VECHILES: Configurations of hybrids, Series and Parallel, advantages and limitations, Hybrid drive trains, sizing of components Initial acceleration, rated vehicle velocity, Maximum velocity and maximum grade ability, Hydrogen: Production, Hydrogen storage systems, reformers.

FUEL CELL VECHILES: Introduction, Fuel cell characteristics, Thermodynamics of fuel cells, Fuel cell types: emphasis on PEM fuel cell.

TEXT BOOKS:

1. J.B. Heywood Internal Combustion Engine Fundamentals, McGraw Hill Co.1988

2. Seth Leitman and Bob Brant Build your own electric vehicle McGraw Hill Co.2009.

3. F. Barbir PEM Fuel Cells-Theory and Practice Elsevier Academic Press,2005.

REFERENCES:

1. W.W. Pulkrabek Engineering Fundamentals of IC Engine, PHI Pvt. Ltd 2002

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

I Year - I Semester		L	T	P	C
		0	0	3	2
COMPUTATIONAL FLUID DYNAMICS LAB					

1. Analysis of Transient state compressible flow through pipes.
2. Performance Analysis of Heat Exchanger Device.
3. Performance characteristics of Combustion.
4. Estimation of C.O.P of Refrigeration Cycle.
5. Analysis of Air-Cooler.
6. Performance of Gas cooled Air-Conditioner.
7. Thermal Stresses in long cylinder.
8. Determination of Insulated Wall Temperature.
9. Temperature Gradient across solid Cylinder.
10. Radiation Heat Transfer between Concentric Cylinders.
11. Solid- Liquid phase change.

    Thermal Loading on Support structure.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

I Year - I Semester		L	T	P	C
		0	0	3	2
THERMAL ENGINEERING LAB					

1. Performance test and analysis of exhaust gases of a duel fuel C.I. Engine.
2. Heat Balance sheet, Volumetric Efficiency and air – fuel ratio estimation of an I.C. Engine.
3. COP estimation of vapor compression refrigeration test Rig through Capillary tube.
4. COP estimation of vapor compression refrigeration test Rig. (Through thermostatic expansion device).
5. Measurement of boundary layer thickness over an object using wind tunnel.
6. Measurement of lift and drag forces over an object using wind tunnel.
7. Performance test and analysis of exhaust gases of a VCR Engine using 5- gas Analyzer.
8. Performance test on Multi-Cylinder Engine
9. Flame propagation analysis of gaseous fuels.
10. Determination of Calorific Value of fuel using Bomb Calorimeter.
11. Performance test on Rotary Air Compressor.
12. Measurement of Dryness Fraction by using Throttling Calorimeter.
13. Demonstration of Heat Pipe Characteristics.
14. Performance Evaluation of Parallel flow and Counter flow Heat Exchanger.
15. Determination of Heat Transfer Coefficient in boiling and Condensation.
16. Calibration of Pressure Gauge and Thermocouple.

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

I Year - I Semester		L	T	P	C
		2	0	0	2
RESEARCH METHODOLOGY AND IPR					

UNIT 1:
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT 2:
Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT 3:
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT 4:
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT 5:
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

(1) Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
(2) Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
(3) Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
(4) Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
(5) Mayall, "Industrial Design", McGraw Hill, 1992.
(6) Niebel, "Product Design", McGraw Hill, 1974.
(7) Asimov, "Introduction to Design", Prentice Hall, 1962.
(8) (8) Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
(9) T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

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

I Year - I Semester		L	T	P	C
		2	0	0	0
SOFT SKILLS					

UNIT-I

Planning and Preparation, Word Order, Breaking up long sentences. Structuring Paragraphs and Sentences, Being concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT-II

Clarifying Who Did What, Highlighting your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT-III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT-IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

UNIT-V

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

REFERNCES:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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

UNIT-I:

Frame: Introduction, Loads on the Frames, Construction and Cross sections of the frame, Types of Frames

Automotive Body: Vehicle body styles, Aerodynamic considerations in body profiling: Drag reduction, Drag force calculation.

UNIT-II:

Vehicle Structure: Basic requirement of stiffness and strengthVehicle structure types
Demonstration of Simple Structural Surfaces (SSS).

UNIT-III:

Body Components: Bumpers, Grilles, Sill covers and side airdams, outer moldingsWeather strips, Glass and Mirrors.

UNIT-IV:

Body Interiors: Seat Belt Restraint system-Air-Bag, components of Air- Bag, Dash Board

Vehicle Safety: Introduction, Crash testing, protection of occupantsTesting for occupants safety, safety controls.

UNIT-V:

Noise: Interior noise-Engine noise, Road noise, wind noise, brake noise, Interior noise: Assessment and control

TEXT BOOKS:

1. Powloski J, Vehicle Body Engineering, Business Books Ltd, 2000.
2. Lorenzo Morello, Automotive Body, Volume-I (component design), Springer, 2011
3. David A Crolla, Automotive Engineering (Power Train, Chassis system and Vehicle Body), Elsevier collection, 2009.

REFERENCE BOOKS:

1. Giles G.J. Body Construction & Design Illiffe Books Butter worth & co., 2000.
2. John Fenton Vehicle Body Layout and Analysis, Mechanical Engineering Publication Ltd., London, 2001.

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

UNIT-I:

Introduction: Hypothetical vehicle control loop, Fundamental Approach, Vehicle co-ordinates, motion variables. Forces – Dynamic axle loads, Static loads on level ground, aerodynamic forces on body, hitch forces, tire construction, size and load rating, terminology, mechanics of force generation – problems

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-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:

Vehicle Vibration and Ride characteristics: Excitation sources – road roughness, wheel assembly, driveline excitation, engine transmission. Wheel Hop Resonance. Rigid body bounce, pitch motion. Effect of vibration on vehicle riding. Influence of pressure in tyre, alignment toe in and toe out, tire wear and tire life.

UNIT-IV:

Steady–State Cornering: Introduction, Low and high speed turning –Tire cornering forces, governing expressions, under steer gradient, over steer and neutral conditions. Characteristic speed, critical speed, yaw velocity gain, sideslip angle, static margin. Suspension effects on cornering

UNIT-V:

Suspension – Solid axes – Independent suspension, Trail arm, Front – Trailing rear suspension – Anti-squat and anti- pitch suspension geometry, roll center analysis, Active suspension, suspension load vehicle loading, load due to gyroscopic force on suspension, total load on suspension.

TEXT BOOKS:

1. Amitosh D, Vehicle Dynamics, Galgotia Book Ltd., 2010.
2. Rao V Dukkipati, Road Vehicle Dynamics,Springer 2008

REFERENCE BOOKS:

1. Hans B Pacejka, Tire and Vehicle Dynamics,3rd Edition, Elsevier Ltd., 2012.
2. Werner and Karl, Ground Vehicle Dynamics,Springer Berlin Heidelberg, 2008.
3. Wong H, Theory of Ground Vehicles, McGraw Hill, Second edition, 2006.

I Year - II Semester		L	T	P	C
		3	0	0	3
NOISE, VIBRATIONS & HARSHNESS					

Unit-I

NVH in the Automotive Industry

Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

Unit-II

Sound and Vibration Theory

Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

Unit-III

Test Facilities and Instrumentation

Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis.

Unit-IV

Signal Processing

Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

Unit-V

NVH Control Strategies & Comfort

Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

TEXT BOOKS:

1. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,2001
2. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 2002

REFERENCES:

1. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 2000.
2. Ewins D. J., Model Testing : Theory and Practice, John Wiley,1995.
3. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993.
4. McConnell K, “Vibration Testing Theory and Practice”, John Wiley, 1995.

I Year - II Semester		L	T	P	C
		3	0	0	3
CONDITION MONITORING					

Unit-I

Predictive maintenance: Introduction, Principles of predictive maintenance, Predictive maintenance techniques, Vibration basics, Spring-mass system: mass, stiffness, damping, System response, Nature of vibration, Harmonics, Limits and standards of vibration.

Unit-II

Data acquisition and Signal processing: Introduction, Collection of vibration signal, vibration transducers, characteristics and mountings, Conversion of vibrations to electrical signal, Fast Fourier transform (FFT) analysis, Time waveform analysis, Phase signal analysis.

Unit-III

Machinery fault diagnosis and Correcting faults: Commonly witnessed machinery faults diagnosed, Balancing, Alignment, Resonance vibration control with dynamic absorbers.

Unit-IV

Oil and particle analysis: Oil fundamentals, Condition-based maintenance and oil analysis, sampling methods, lubricant properties, contaminants in lubricants, wear debris, Particle analysis techniques, temperature analysis.

Unit-V

Other predictive maintenance techniques: Non-destructive techniques, Ultrasound, Infrared thermography, Introduction to structural health monitoring.

TEXT BOOKS:

1. Rao, J S., Vibration Condition Monitoring, Narosa Publishing House, 2nd Edition, 2000.

REFERENCES:

1.Allan Davies, Handbook of Condition Monitoring, Chapman and Hall, 2000.

2.Isermann R., Fault Diagnosis Applications, Springer-Verlag, Berlin, 2011.

I Year - II Semester		L	T	P	C
		3	0	0	3
AUTOMOTIVE AIR CONDITIONING SYSTEMS					

UNIT I

FUNDAMENTALS

Terminology, design factors and concepts related to air conditioning system – Construction and Working principles of Thermostatic Expansion valve and Orifice tube based system- Heating system types -detailed study of HVAC components like compressor, evaporator, condenser, TXV, orifice tube, Receiver-drier, heater core etc. Location of air conditioning components in a vehicle.

UNIT II

REFRIGERANTS & AIR MANAGEMENT SYSTEMS

Refrigerants: Temperature and pressure relation, Properties of R-12 and R134a- refrigerant oil. Simple problems -Containers - Handling refrigerants - Tapping into the refrigerant container - Ozone Layer Depletion. Air management system: Air routing for manual, semi and automatic system- cases and ducts- Air distribution, control head and doors- Defrost system

UNIT III

AUTOMATIC CLIMATE CONTROL SYSTEM

Block diagram - types of Sensors and Actuators, - Control Logic Electrical wiring diagram of manual and automatic system - multiplexing between BCM and PCM- control of compressor clutch, blower motor etc.- diagnostics tools and features.

UNIT IV

DESIGN OF AIR-CONDITIONING COMPONENTS

Modeling of Fixed and variable Displacement type compressor, evaporator modeling – heat transfer correlations for the fluids inside the evaporator, analysis of evaporator frosting- condenser modeling - improvement of refrigerant flow control method.

UNIT V

AIR CONDITIONING DIAGNOSIS AND SERVICES

AC system diagnosis based on temperature and pressure measurements, sight glass, sound etc. - refrigerant leak detection- Trouble shooting and Servicing of compressor, evaporator, condenser, heater core – HVAC equipment , recovery and charging. Air routing system service.

TEXT BOOKS:

1. Tom Birch, “Automotive Heating and Air Conditioning” Pearson Education Inc., 2003.
2. William H Crouse and Donald L Anglin, “Automotive air conditioning”, McGraw – Hill Inc.,1990

REFERENCES :

1.Boyce H. Dwiggins, Jack Erjavec., “Automotive Heating and Air-Conditioning”, Delmer publisher.,2001.
2.Steven Daly “Automotive Air Conditioning and Climate Control System”, Butterworth-Heinemann., 2006
3.Paul Weiser, “Automotive air conditioning”, Reston Publishing Co Inc., 1990.
4.James D. Halderman, “Automotive Heating, Ventilation, and Air Conditioning Systems”,
5.Pearson Education Inc., 2004.

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

I Year - II Semester		L	T	P	C
		3	0	0	3
AUTOMOTIVE SYSTEM COMPONENTS DESIGN					

UNIT I:
INTRODUCTION: Engineering materials - Introduction endurance limit, notch sensitivity. Tolerances, types of tolerances and fits, design considerations for interference fits, surface finish, surface roughness, Rankine's formula - Tetmajer's formula - Johnson formula- design of pushrods.

UNIT II:
DESIGN OF CYLINDER, PISTON AND CONNECTING ROD: Choice of material for cylinder and piston, design of cylinder, piston, piston pin, piston rings, piston failures, lubrication of piston assembly. Material for connecting rod, determining minimum length of connecting rod, small end design, shank design, design of big end cap bolts.

UNIT III:
DESIGN OF CRANKSHAFT: Balancing of I.C. engines, significance of firing order. Material for crankshaft, design of crankshaft under bending and twisting, balancing weight calculations, development of short and long crankarms. Front and rear-end details.

UNIT IV:
DESIGN OF FLYWHEELS: Determination of the mass of a flywheel for a given co- efficient of speed fluctuation. Engine flywheel - stresses on the rim of the flywheels. Design of hubs and arms of the flywheel, turning moment diagram.

UNIT V:
DESIGN OF VALVES AND VALVE TRAIN: Design aspects of intake & exhaust manifolds, inlet & exhaust valves, valve springs, tappets and valve train. Design of cam & camshaft. Design of rocker arm. Cam profile generation.

TEXT BOOKS:

1. Automobile Design, R. N. Bahl, Dreamtech Press, 2019
2. Mechanical Engineering Design, J. SHigley, etal, McGrawHill Publishers
3. New Engine and Component Design Technology, SAE Publications.

REFERENCE BOOKS:

1. Machine Design, Robert L. Norton, Pearson Publishers.
2. Jain.R.K, "Machine Design", Khanna Publishers, New Delhi, 2005.
2. Giri.N.K, "Automobile Mechanics", Khanna Publishers, New Delhi, 2007.

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

I Year - II Semester		L	T	P	C
		3	0	0	3
ADVANCED METAL FORMING					

UNIT-I

Introduction Metal forming as a manufacturing process and its relation with other processes – Classification based on type of stresses - Examples.

Theoretical analysis (theory of plasticity), Stress-strain relationship, Strain hardening, Material incompressibility, Work of plastic deformation, Work hardening, Yield criteria, Flow rule, Yield criterion and flow rule for Anisotropic material, Initiation and extent of plastic flow- Problems.

Overview of various metal forming operations: Mechanics of Various Plastic Flow Problems Introduction to; (i). Theory of slip lines, Upper bound theorem, Lower bound theorem.

UNIT-II

Forging processes: Metal flow in forging, Analysis of plane strain compression, Analysis of compression of circular disc with slab method.

Extrusion Processes: Calculation of extrusion load using slab method, slip line method and upper bound method. Defects in extrusion. Direct & indirect extrusion.

Wire Drawing Processes: Introduction, wire drawing load calculation using slab method.

UNIT-III

Rolling Processes: Analysis of longitudinal strip or sheet rolling process (calculation of roll separating force, torque & power, angle of bite, maximum reduction in rolling), rolling defects.

Sheet forming: Mechanics – Flow Rules – Anisotropy - Formability of sheet, Formability tests, forming limit diagrams, Case studies.

Pressing and Sintering: Workability Studies – Densification - Problems & Case Studies

UNIT-IV

Incremental Forming: Statics and Kinematics of Incremental Stresses and Strains - The Kinematics of Two-Dimensional Strain, The Kinematics of Three-Dimensional Strain, Incremental Stresses in Two Dimensions, Incremental Stresses in Three Dimensions, Equilibrium Equations for the Stress Field in Two Dimensions, Equilibrium Equations for the Stress Field in Three Dimensions,

UNIT-V

Modeling and Simulation in Metal Forming: Plasticity and Viscoelasticity – Constitutive relations - The Plane Strain Compression Test, FEM Model and Input Data to the Model - Deformations in the Compression Gap - Effective Strain and Strain-Rate Distributions in Deformed Zones - Damage Parameter and Edge Cracking.

TEXT BOOKS:

1..Surender Kumar, Technology of Metal Forming Processes, Prentice - Hall, Inc., 2008.

REFERENCES:

1. Henry S. Valberg, Applied Metal Forming - Including FEM Analysis, Cambridge University Press, 2010.
2. Metal Forming: Mechanics and Metallurgy by William F. Hosford and Robert M. Caddell, Prentice-Hall (USA) – 2012
3. Slater.RA.C.Engineering Plasticity-Theory & Applications to Metal Forming, John Wiley and Sons, 1987.
4. Shiro Kobayashi,Altan.T, Metal Forming and Finite Element Method, Oxford University Press, 1989
5. Maurice A. Biot, Mechanics of Incremental Deformations, John Wiley & Sons,2008

I Year - II Semester		L	T	P	C
		3	0	0	3
AUTOMOTIVE SAFETY AND MAINTENANCE					

Unit-I

Introduction

Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction.

safety concepts

Active safety: driving safety, conditional safety, perceptibility safety, operating safety, passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

Safety equipments

Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety.

Unit-II

Collision warning and avoidance

Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system interactions.

Comfort and convenience system

Steering and mirror adjustment, central locking system, Garage door opening system, tyre pressure control system, rain sensor system, environment information system.

Engine and engine subsystem maintenance

General Engine service- Dismantling of Engine components- Engine repair- working on the underside, front, top, ancillaries- Service of basic engine parts, cooling and lubricating system,

fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management service - fault diagnosis- servicing emission controls

Unit-III

Transmission and driveline maintenance

Clutch- general checks, adjustment and service- Dismantling, identifying, checking and reassembling transmission, transaxle- road testing- Removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints- Rear axle service points- removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

Unit-IV

Steering, brake, suspension, wheel maintenance

Inspection, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, Parkingbrake.Bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Dismantling and assembly procedures. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and Service of steering linkage, steering column, Rack and pinion steering, Recirculating ball steering service- Worm type steering, power steering system

Unit-V

Auto electrical and air conditioning maintenance

Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Replacement of hoses- Leak detection- AC Charging- Fault diagnosis Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

TEXT BOOKS:

1. Ed May, "Automotive Mechanics Volume One" , McGraw Hill Publications, 2003
2. Ed May, "Automotive Mechanics Volume Two" , McGraw Hill Publications, 2003

REFERENCES:

1. Bosch, “Automotive Handbook”, 8 th Edition, SAE publication, 2011.
2. Vehicle Service Manuals of reputed manufacturers
3. JullianHappian-Smith ‘An Introduction to Modern Vehicle Design’ SAE, 2002
4. Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London, 1995
5. Rollover Prevention, Crash Avoidance, Crashworthiness, Ergonomics and Human Factors”, SAE Special Publication, November 2003

I Year - II Semester		L	T	P	C
		3	0	0	3
ADVANCED FINITE ELEMENT METHODS					

UNIT – I

FORMULATION TECHNIQUES: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – II

ONE-DIMENSIONAL ELEMENTS: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – III

TWO DIMENSIONAL PROBLEMS: CST, LST, four nodded and eight nodded rectangular elements,
Lagrange basis for triangles and rectangles, serendipity interpolation functions.
Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT – IV

ISOPARAMETRIC FORMULATION: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

UNIT – V

FINITE ELEMENTS IN STRUCTURAL ANALYSIS: Static and dynamic analysis, eigen value problems,
and their solution methods, case studies using commercial finite element packages.

TEXT BOOK:

1. Finite element methods by Chandrubatla & Belagondu.

REFERENCES:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996

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

I Year - II Semester		L	T	P	C
		3	0	0	3
VEHICLE CONTROL SYSTEMS					

UNIT I
INTRODUCTION
Components of chassis management system – role of various sensors and actuators pertaining to chassis system – construction – working principle of wheel speed sensor, steering position, tyre pressure, brake pressure, steering torque, fuel level, Engine and vehicle design data.

UNIT II
DRIVELINE CONTROL SYSTEM
Speed control – cylinder cut - off technology, Gear shifting control – Traction / braking control, brake-by-wire – Adaptive cruise control, throttle by wire. Steering - power steering, collapsible and tiltable steering column – steer by wire.

UNIT III
SAFETY AND SECURITY SYSTEM
Airbags, seat belt tightening system, collision warning systems, child Lock, anti lock braking systems, Vision enhancement, road recognition system, Anti theft technologies, smart card system, number plate coding, central locking system.

UNIT IV
COMFORT SYSTEM
Active suspension systems, requirement and characteristics, different types, Vehicle Handling and Ride characteristics of road vehicle, pitch, yaw, bounce control, power windows, thermal management system, adaptive noise control.

UNIT V
INTELLIGENT TRANSPORTATION SYSTEM
Traffic routing system - Automated highway systems - Lane warning system – Driver Information System, driver assistance systems - Data communication within the car, Driver conditioning warning - Route Guidance and Navigation Systems – vision enhancement system - In-Vehicle Computing – Vehicle Diagnostics system – Hybrid / Electric and Future Cars – Case studies.

.

TEXT BOOKS:

1.U. Kiencke, and L. Nielsen, Automotive Control Systems, SAE and Springer-Verlag, 2000.
2.Crouse, W.H. & Anglin, D.L., “Automotive Mechanics”, Intl. Student edition, 9th edition, TMH, New Delhi, 2002

REFERENCES:

1.Ljubo Vlacic, Michel Parent, Fumio Harashima, “Intelligent Vehicle Technologies”, Butterworth-Heinemann publications, Oxford, 2001.
2.William B.Ribbens -Understanding Automotive Electronics, 5th edition, Butter worth Heinemann Woburn, 1998.
3.Bosch, “Automotive Handbook”, 6th edition, SAE, 2004.

I Year - II Semester		L	T	P	C
		3	0	0	3
SIMULATION OF VEHICLE SYSTEMS					

UNIT I

INTRODUCTION Introduction to Modeling and simulation, Role of modeling and simulation, Modeling and simulation process, Discrete event dynamic systems, Continuous time dynamic systems

UNIT II

MODELING & SIMULATION OF DRIVETRAIN SYSTEM Basic driveline model, Modeling of neutral gear, Driveline control – Goals, state space formulation, controller formulation, Driveline control for Speed, Driveline control for gear shifting, Modeling and simulation of power train of a passenger car

UNIT III

MODELING & SIMULATION OF SUSPENSION SYSTEM Passive suspension - Natural Frequencies and Mode Shapes - Approximate Transfer Functions - Analysis of Vibrations in the Sprung Mass Mode and Unsprung Mass Mode - Verification Using Quarter Model. Half-Car and Full-Car Suspension Models, Semi-active suspension - Optimal Semi-Active Control Law, Calculation of Transfer Function Plots - Performance of Semi-Active Suspension Systems, Active Automotive Suspensions 37

UNIT IV

MODELING & SIMULATION OF BRAKING SYSTEMS Friction models, Lumped parameter models – drum brake and disc brake, Modal approach for brake disk vibrations, Electronic stability program – Brake slip controller, Traction slip controller, Electronic brake force distribution, Brake assist

UNIT V

MODELING AND SIMULATION OF COMPLETE VEHICLE Wheel model – wheel ground contact point velocities, tire side slip angle, friction co-efficient, Chassis translatory motion, Chassis rotational motion, suspension model, vehicle stability analysis, validation of vehicle model

TEXT BOOKS:

1.Rajesh Rajamani, “Vehicle Dynamics and Control”, Springer, 2006
2. Dieter Schramm, Manfred Hiller, Roberto Bardini –“ Vehicle Dynamics Modeling and Simulation”, Springer-Verlag Berlin Heidelberg, 2014

REFERENCES

1.Giampiero mastinu, Manfred Ploechl – “Road and off road Vehicle System dynamics handbook”, CRC press, Boca Raton, USA, 2014
2. Louis G. Birta, Gilbert Arbez- “Modelling and Simulation Exploring Dynamic System Behaviour”, Springer, London, 2013
3. Uwe Kiencke, Lars Nielsen – “Automotive Control Systems For Engine, Driveline, and Vehicle”,

I Year - II Semester		L	T	P	C
		0	0	3	2
MODELING AND SIMULATION LAB					

1. Declination of earth, hour angel, day length, local apparent time, monthly average, hourly global and diffuse ration on a horizontal surface and tilted surfaces.
2. Power generation from a wind turbine, variation of wind velocity and power with altitude.
3. Simulation of flat plate solar collector in natural circulation and forced circulation.
4. Simulation of concentrating solar collector in natural circulation and forced circulation.
5. Simulation of solar Dryer.
6. Simulation of solar still.
7. Simulation of Solar cooker.
8. Simulation of DMFC fuel cell.
9. Simulation of PEM fuel cell.
10. Simulation of Rankine cycle.
11. Simulation of Brayton cycle.
12. Simulation of combined cycle.

Simulation of power generation through wind turbine.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		0	0	3	2
AUTOMOTIVE SYSTEMS LAB					

1. Assemble and Dismantle the Old Vehicle to Study the Parts
2. Study of Power steering system, Braking System, Gear Box and Clutch assembly
3. Draw the Valve Timing Diagram of a given Engine
4. Wheel alignment test
5. On board diagnostic test
6. Vehicle performance test using chassis dynamometer
7. Wind resistance test
8. Fuel consumption test
9. Vehicle emission measurement using chassis dynamometer as per Indian Driving Cycle (IDC)
10. Study of Vehicle lighting system and bendix drive
11. V-I characteristics of solar simulator in different configurations
12. Performance test on PEM fuel cell

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		2	0	0	2
MINI PROJECT WITH SEMINAR					

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

I Year - II Semester		L	T	P	C
		2	0	0	0
VALUE EDUCATION					

Course Objectives

Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Syllabus

Unit	Content	Hours
1	• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgements	4
2	• Importance of cultivation of values. • Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. • Honesty, Humanity. Power of faith, National Unity. • Patriotism.Love for nature ,Discipline	6
3	• Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labour. • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature	6
4	• Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Nonviolence ,Humility, Role of Women. • All religions and same message. • Mind your Mind, Self-control. • Honesty, Studying effectively	6

Suggested reading

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Course outcomes

Students will be able to 1.Knowledge of self-development

II Year - I Semester		L	T	P	C
		3	0	0	3
VEHICLE TESTING AND INSTRUMENTATION					

Unit-I

Introduction: Overview of the course-Need of vehicle testing (engine testing both for performance and emissions in specific)-Requirement of standard instrumentation and equipment, certification and national and international standards, Importance of expertise in testing, certification.

Measurement fundamentals: Definitions associated with measurements-Least count, resolution, Precision, Accuracy, Error / Uncertainty analysis- Data collection and handling- Simple numerical problems.

Unit-II

Engine Testing: Definition and importance of engine in a vehicle- Road load equation- Testing under constant speed and variable speed condition. Classification of engine dynamometers-Characteristic curves of various types of dynamometers-Advantage and limitations of different types engine dynamometers-Discussion on typical engine performance characteristics.

Combustion analysis: Definition of Combustion, Combustion stoichiometry, SI engine combustion and CI engine combustion-Measurement of in-cylinder pressure, temperatures-instrumentation

Unit-III

Fuel injection systems: Fuel injection for SI and CI engines, Types of different systems-Electronic injection systems and Electronic Control Units-Testing of injection systems.

Vehicle Emissions: Types of emissions and pollutant formation mechanisms-Vehicle Driving Cycles, Emission measurement on engine and chassis dynamometer-Measurement of regulated and non-regulated pollutants-Description of emission measuring instrumentation-

NDIR, FID, Chemiluminescence Analyzer, Chromatograph, Smoke meters -Emission regulations and legislation- EURO and Bharat Stage norms

Unit-IV

Vehicle performance and testing techniques: Schematic layout of typical vehicle-Types of testing for both engine in specific, and whole vehicle body. Description of important components of Vehicle and Engine that require testing. Different types of engines for Vehicles- fossil fuel run engines, hybrid and electric vehicles -Testing procedure for electric vehicles- -Chassis and Rolling road dynamometers-Brief introduction to testing of tires, steering, brakes, wheel alignment-Introduction to on-board diagnostics.

Unit-V

Vehicle Drag & Aerodynamics of Vehicle: Introduction to drag and aerodynamics, Description drag-terms associated; streamlined and bluff bodies-Definition of Ahmed car- adverse effects of drag-Drag measuring techniques-drag reduction strategies

Vehicle certification: Need for Vehicle certification and facilities required, Importance driving cycles-Indian Driving Cycle, MIDC-procedures, Introduction to other country driving cycle-Japan, EUDC

TEXT BOOKS:

1. Heinz Heisler, Advance Vehicle Technology, Butterworth-Heinemann, 2002
2. J.P. Holman, Experimental Methods for Engineers, Tata McGraw Hill Co. 2007.

REFERENCES:

1.Tom Denton, Advanced Automotive Fault Diagnosis, Elsevier Butterworth-Heinemann,2006
2.Martyr and Plint, Engine testing-theory and Practice, Butterworth-Heinemann, 2002.

II Year - I Semester		L	T	P	C
		3	0	0	3
ENGINE MANAGEMENT SYSTEMS					

Unit-I

Computerized Electronic Fuel Injection: Engine Input Sensors-
Coolant & Intake Temperature, Crankshaft Position, Camshaft Position, Manifold Absolute Pressure, Throttle Position, Oxygen, Air/Fuel Ratio, Knock Speed& Distance, Battery & Switches
Output Devices -Relays, Injector Sequencing & Management, Ignition Operation, Idle Air Control, EGR, EVAP, Waste gate Solenoids, Torque Converter & Speed Control, Malfunction Indicator Light

Unit-II

Speed Density/Mass Air Flow Fuel Management Strategies:
Key ON Mode, Crank Mode, Open & Closed Loop, Wide-Open Throttle, Adaptive Memory Cells, Cruise &Deceleration, Wide-Open Throttle, Key OFF Mode

Fuel Injection Systems -Electronic Fuel Systems, Computer Self-Diagnostic Circuits, Electronic Throttle Actuator Control Systems, Fuel Control, Fuel Supply System Control, Injection System Inspection and Maintenance.

Unit-III

Engine Diagnostic Procedures
Fuel System testing, On Board Diagnostics, Monitored &Non Monitored Circuits, Diagnostic Trouble Codes

Digital Engine Control System:
Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.

Unit-IV

SI Engine Management: Feedback carburetor system, throttle body injection and multi point fuel injection system, injection system controls, advantage of electronic ignition systems,

three-way catalytic converter, conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch Monojetronic, L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Working of the fuel system components. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control.

Unit-V

CI Engine Management: Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems.

TEXT BOOKS:

1. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
2. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

REFERENCES:

1.Halderman, J. & Linder, J. (2012). Automotive Fuel and Emissions Control Systems (3rd Edition)Upper Saddle River, NJ: Pearson Education.
2.Halderman, J. D. (2011). Diagnosis &Troubleshooting of Automotive Electrical, Electronic, &Computer Systems (6th Edition) Upper Saddle River, NJ: Pearson Education.
3. Understanding Automotive Electronics – Bechfold SAE 1998
4. Automobile Electronics by Eric Chowanietz SAE
5. Fundamentals of Automotive Electronics - V.A.W.Hilliers - Hatchin, London

6.Automobile Electrical & Electronic Equipments (2000) Young, Griffitns - Butterworths, London.
7.Understanding Automotive Electronics, Wiliam B. Ribbens, 5th Edition, Newnes, Butterworth–Heinemann, 2001.
8.Automotive Computers & Digital Instrumentation – Robert N. Brandy, Prentice Hall, 2004
9.The Fundamentals of Electrical Systems - John Hartly - Longman Scientific & Technical, 2002.

II Year - I Semester		L	T	P	C
		3	0	0	3
DESIGN AND ANALYSIS OF EXPERIMENTS					

Unit-I

Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation

Unit-II

Simple Comparative Experiments: Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA

Unit-III

Experimental Designs: Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data

Unit-IV

Response Surface Methodology: Concept, linear model, steepest ascent, second order model, regression

Unit-V

Taguchi's Parameter Design: Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis

TEXT BOOKS:

1.Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.

REFERENCES:

1.Ross PJ, Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008.

II Year - I Semester		L	T	P	C
		3	0	0	3
SPECIAL TYPES OF VEHICLES					

UNIT I

EARTH MOVING EQUIPMENTS

Construction layout, capacity, specification and applications of dumpers, articulated haulers, front-end loaders, backhoe loaders, bulldozers, scrappers, motor graders, skid steer loaders ,excavator, hydraulic shovels, bucket conveyors , surface miners – high wall Miners. Selection criteria for prime mover.

UNIT II

CONSTRUCTIONAL EQUIPMENTS

Construction layout, capacity, specification and applications of cranes – types , Articulated Trucks ,concrete ready mixer ,trenchers , Asphalt Pavers , road reclaimers , General description, specification and functions of smooth wheeled rollers, pneumatic tired rollers, , sheep's foot rollers, vibrating compactors , draglines, drillers ,bore well machine

UNIT III

FARM EQUIPMEMTS

Classification of tractors – Main components of tractor. Working attachment of tractors – Auxiliary equipment –- Top lifting harvesters. General description, working, specification and functions of paddy harvesting machines, Sugarcane harvesting, feller bunchers, forest machines.

UNIT IV

INDUSTRIAL VEHICLE

General description, specification, capacity and working of fork lifts - attachment, Utility vehicles, towing vehicles, man-lift chassis, scissor lift trucks, material handlers, fire fighting vehicle, reclaimers, Street sweepers

UNIT V

MILITARY AND COMBAT VEHICLES

Special features and constructional details of Main Battle tank, gun carriers, truck-mounted missile launchers, transport vehicles, armored vehicle-launched bridge, amphibious bridging vehicle, and communication vehicles.

TEXT BOOKS:

1.Peurifoy R.L "Construction Planning, Equipment and Methods", Tata McGraw-Hill, New Delhi, 2002.

REFERENCES:

1.Abrosimov. K. Bran berg.A. andKatayer.K., " Road making Machinery ", MIR Publishers, Moscow, 1971.
2.Jerry Scutts, "Advanced Military Vehicle Modelling" , Osprey Publishing, 1999
3.Rodichev and G.Rodicheva, Tractor and Automobiles, MIR Publishers, 1987.
4.B. Geleman and M. Moskovin, Farm tractors, MIR publishers, Moscow.
5.Kolchin,A., and V.Demidov, Design of Automotive Engines for Tractor, MIR Publishers, 1972.
6.Off the road wheeled and combined traction devices - Ashgate Publishing Co. Ltd. 1998.
7.Wong J " Terramechanics and Off-Road Vehicle Engineering", Butterworth-Heinemann, 2009

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

II Year - I Semester		L	T	P	C
		3	0	0	3
COMPOSITE MATERIALS AND STRUCTURE					

UNIT I
CLASSIFICATION AND CHARACTERISTIC OF COMPOSITE MATERIALS
Need for the composite materials. Types of composite materials and their use in structures.

UNIT II
BASIC CONCEPTS Hooke‟s law for orthotropic and anisotropic materials. Micromechanics and macro mechanics. Lamina stress-strain relations referred and principal material directions and arbitrary axes.

UNIT III
ANALYSIS OF LAMINATED COMPOSITES Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Inter laminar stresses.

UNIT IV
OTHER METHODS OF ANALYSIS AND FAILURE THEORY Netting analysis, Failure criteria. Sandwich construction.

UNIT V
MANUFACTURING & FABRICATION PROCESSES 10 Manufacturing of glass, boron and carbon fibers. Open mould and closed mould processes.

TEXT BOOKS:

1. B.D. Agarwal and L.J. Broutman, “Analysis and Performance of fiber composites”, JohnWiley and Sons, 1980.

REFERENCES

1. R.M. Jones, “Mechanics of composite materials”, McGraw-Hill, Kogakusha Ltd., Tokyo, 1975.
2. L.R. Calcote, “Analysis of laminated structures”, Van Nostrand Reinhold Co., 1989.
3. G.Lubin, “Hand Book on Fibre glass and advanced plastic composites”, Van Nostrand Co., New York, 1989.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA - 533 003, Andhra Pradesh, India

II Year - I Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	OPEN ELECTIVE				

Students are advised to opt for an open elective course of their choice being offered by other departments of institute

(OR)

MOOCS/NPTEL Certification courses duly approved by the department

II Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**20**	**10**
	DISSERTATION **(Phase I)**				

II Year - I Semester		**L**	**T**	**P**	**C**
		0	**0**	**32**	**16**
	DISSERTATION **(Phase II)**				