JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech. (Advanced I.C. Engines)

(4 SEMESTER COURSE STRUCTURE AND SYLLABUS)

EFFECTIVE FROM THE YEAR 2015-16

I- SEMESTER:

Subject Code	SUBJECT	L	P	C
15D31102	Advanced Thermodynamics	4	-	4
15D31103	Conduction and Radiation Heat Transfer	4	-	4
15D33101	Internal Combustion Engineering	4	-	4
15D33102	Alternative Fuels for I.C. Engines	4	-	4
	ELECTIVE-I	4	-	4
15D33103	Automotive Air Conditioning Systems			
15D33104	Alternative Fuels and Propulsion Systems			
15D33105	Turbo Machines			
15D33106	Theory of Fuels and Lubricants			
	ELECTIVE-II	4	-	4
15D33107	Automobile Air Pollution and Environment			
15D33108	Jet propulsion & Rocket Engineering			
15D33109	Electric and Hybrid Vehicles			
15D33110	Production of Automobile Components			
15D33111	"Performance Testing of Internal Combustion Engines" Lab	0	4	2
TOTAL		**24**	**4**	**26**

II - SEMESTER:

Subject Code	SUBJECT	L	P	C
15D33201	Combustion in I.C. Engines	4	-	4
15D31202	Convective Heat & Mass Transfer	4	-	4
15D31204	Advanced Fluid Mechanics	4	-	4
15D33202	Engine Emissions and Control	4	-	4
	ELECTIVE-III	4	-	4
15D33203	Super Charging & Scavenging.			
15D33204	Vehicle Maintenance			
15D33205	Engine Management Systems			
15D33206	Instrumentation and Experimental Techniques			
	ELECTIVE-IV	4	-	4
15D33207	Automotive Aerodynamics			
15D33208	Vehicle Control Systems			
15D33209	Manufacturing and Testing of I.C. Engines and Components			
15D33210	Automotive Safety			
15D54201	Research Methodology (Audit Course)			
15D33211	"Testing of Combustion & Emissions of Internal Combustion Engines" Lab	0	4	2
TOTAL		**24**	**4**	**26**

Code	Subject	T	P	C
15D33301	**III Semester Seminar - I**	**0**	**4**	**2**
15D33401	**IV Semester Seminar - II**	**0**	**4**	**2**
15D33302	**III & IV Semester Project Work**	**--**	**--**	**44**
	Total	**24**	**8**	**48**

Note : All End Examinations (Theory and Practical) are of Three Hours Duration.

T – Tutorial L – Theory P- Practical / Drawing C - Credits

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(4 SEMESTER COURSE STRUCTURE AND SYLLABUS)

EFFECTIVE FROM THE YEAR 2015-16

I- SEMESTER:

Subject Code	SUBJECT	L	P	C
15D31102	Advanced Thermodynamics	4	-	4
15D31103	Conduction and Radiation Heat Transfer	4	-	4
15D33101	Internal Combustion Engineering	4	-	4
15D33102	Alternative Fuels for I.C. Engines	4	-	4
	ELECTIVE-I	4	-	4
15D33103	Automotive Air Conditioning Systems			
15D33104	Alternative Fuels and Propulsion Systems			
15D33105	Turbo Machines			
15D33106	Theory of Fuels and Lubricants			
	ELECTIVE-II	4	-	4
15D33107	Automobile Air Pollution and Environment			
15D33108	Jet propulsion & Rocket Engineering			
15D33109	Electric and Hybrid Vehicles			
15D33110	Production of Automobile Components			
15D33111	"Performance Testing of Internal Combustion Engines" Lab	0	4	2
TOTAL		**24**	**4**	**26**

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ADVANCED THERMODYNAMICS
(Common to R&A/C & Advanced I.C. Engines)
(15D31102)

UNIT-I

THERMODYNAMIC RELATIONS:

Introduction-Helmhotz free energy function-Gibbs free energy function-coefficient of volumetric expansion-isothermal compressibility-differential relation for U,H,G&F-Maxwell relations.

GENERALIZED RELATIONS:

Generalized relation for Cp,Cv,K,B-relations for internal energy and enthalpy-the various Tds equation-clapeyron equation-gas tables-enthalpy and internal energy- pressure ratio-volume ratio-change of entropy-Introduction to third law of thermodynamics.

UNIT-II

EXERGY:

Introduction-availability of heat –availability of a closed system-availability function of the closed system-availability of steady flow system- availability function of open system.

IRREVERSIBILITY:

Introduction-irreversibility for closed and open system-steady flow process effectiveness-second law analysis of the power plant.

UNIT-III

NONREACTIVE GAS MIXTURES:

Introduction-basic definitions for gas mixtures-PVT relations ship for mixtures of ideal gases-properties of mixtures of ideal gases-entropy change due to mixing – mixtures of perfect gases at different initial pressure and temperatures.

UNIT-IV

GAS SPOWER CYCLES:

Introduction-air standard cycles-carnot cycle-ottocycle –disel cycle-dual cycles-comparison between Otto, Diesel, dual cycles-variations between the air standard Otto cycle and actual cycle-Sterlling cycle-Erickson cycle-Atkinson cycle-Brayton cycle- Lenoir cycle.

UNIT-V

VAPOUR POWER CYCLES:

Introduction-the carnot vapor cycle-rankine cycle-effects of operation condition on efficiency-principles of increasing the thermal efficiency- method of increasing thermal efficiency.

DIRECT ENERGY CONVERSION:

Introduction-thermoelectric converters-thermo-ionic converters magneto hydrodynamics generators-solar power cells plant –fuel cell hydrogen –hydrogen fuel cells-direct and indirect oxidation fuel cells-biochemeical fuel cells.(no problems)

REFERENCE BOOKS:

1. Advanced Thermodynamics:Van Wyllan, TMGH
2. Engineering Thermodynamics:P.K.Nag,TMGH Advanced Thermodynamics:Ray & Sarao,Central Publishers.

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	4	**-**	**4**

CONDUCTION AND RADIATION HEAT TRANSFER

(Common to R&A/C & Advanced I.C. Engines)

(15D31103)

CONDUCTION :

UNIT-I

Introduction of three modes of heat transfer, steady, unsteady state heat transfer process, governing equations and boundary conditions

Two dimensional steady state conduction, semi-infinite and finite flat plate; temperature field in infinite and finite cylinders.

UNIT-II

Conduction through spherical shells, numerical methods, relaxation method and finite difference methods - simple problems.

UNIT-III

Heating and cooling of bodies with negligible internal resistance, sudden changes in the surface temperature of infinite plates, cylinders and semi-infinite bodies-simple problems.

RADIATION :

UNIT-IV

Review of the thermal radiation - gas radiation, mean beam length exchange between gas volume and black enclosure, heat exchange between gas volume and gray enclosure, problems.

UNIT-V

Radiation network for an absorbing and transmitting medium, radiation exchange with specular surfaces, radiation exchange with transmissivity and reflecting absorbing medium. Formulation for numerical solution.

Solar radiation: Radiation properties of environment, effect of radiation on temperature measurement, the radiation heat transfer coefficient, problems.

REFERENCE BOOKS :

1) Heat Transfer -Gibhart - Mc. Graw Hill.
2) Conduction Heat Transfer- -Schneder Addition Wieslthy
3) Conduction of Heat in Solids -Carslaw & Jaeger.
4) Heat transfer -J.P. Holman, International student edition
5) Fundamentals of heat and mass transfer -R.C. Sachdev New Age International
6). Heat Transfer by - R. K. Rajput Lakshmi Publishers

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

INTERNAL COMBUSTION ENGINEERING
(15D33101)

UNIT –I

Basic characteristics of engines : Compression ratio – energy supply to an engine – power developed by engine – specific weight and specific volume – cylinder pressures – IMEP determination – torque characteristics – cylinder arrangement and their relative merits. Engine cooling systems: types of cooling – cooling of critical engine components – recooling the coolant – comparison of air cooled and liquid cooled engines.

UNIT –II

Fuel delivery in SI engines: Classification of fuel delivery systems – fuel transfer pumps – fixed jet carburetor – computer controlled carburetor – gasoline injection systems. Ignition systems in SI engines: Battery ignition system – requirements for satisfactory operation of the ignition system – ignition timing and advancing mechanisms – magneto ignition system – electronic ignition system.

UNIT – III

Combustion and combustion systems in CI engines: Air motion in CI engines – delay period in CI engines – types of diesel combustion systems. Scavenging and super charging in CI engines : types of scavenging systems in two stroke SI engines – improved and modified scavenging systems – super charging and engine performance – methods of super charging.

UNIT – IV

Engine emissions, control systems and engine developments: SI engine pollutants – exhaust gas analyzer – SI engine emission control systems – particulate emissions – diesel pollution control methods – low heat rejection engines.

UNIT – V

Conventional and alternate fuels for IC engines: desirable characteristics of gasoline – desirable characteristics of diesel fuel – alternative fuels for SI engines and CI engines.

TEXT BOOKS:

1. Internal combustion engines fundamentals by by JohnB. Heywood. McGraw – Hill international editions.
2. Internal combustion engines by V. Ganesan, Tata McGraw Hill book cop. 1995
3. Internal combustion engines and air pollutions by Edward F. Obert, Intext education publishers.
4. Introduction to internal combustion engines by Richard stone 3rd edition , society of automotive engineers .

REFERENCES:

1. A course Internal combustion engines by V.M.A. Domkundwar, Dhanapat Rai publications.
2. A course internal combustion engines by M.L.Mathur and R.P.Sharma, Dhanapat Rai publications.
3. Internal combustion engines by K.k Ramalingam, Scitech Publications (India) Pvt.Ltd, 2000
4. A Text Book of Internal combustion engines by R.K. Rajput, Laxmi Pub, Pvt., 2006

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ALTERNATIVE FUELS FOR I.C. ENGINES
(15D33102)

UNIT-I

Introduction: solid fuels, gases fuels, liquid fuels, chemical structure of petroleum, petroleum refining process, important requisite qualities of engine fuels, SAE rating of fuels.

UNIT-II

FUELS: Availability and Suitability to Piston Engines, Concept of conventional fuels, potential alternative fuels - Ethanol, Methanol, DEE/DME - Hydrogen, LPG, Natural gas, Producer gas, Bio gas and Vegetable oils - Use in I.C.Engines-Merits and Demerits of various fuels.

UNIT-III

ALCOHOL FUELS: Properties as engine fuels - Performance in S.I.Engines - Alcohol & Gasoline blends - Flexible Fuel Vehicle -Reformed alcohols.

Alcohols in C.I. Engines - Emulsions - Dual fuel systems -Spark assisted diesel engines - Surface ignition engines - Ignition accelerators - Manufacture of alcohol fuels.

UNIT-IV

GASEOUS FUELS: Hydrogen - Properties - Use in C.I Engines - Use in S.I Engines - Storage methods - Safety precautions -Production methods.

Production of Producer gas and bio gas - Raw materials - Gasification - Properties - Cleaning up the gas -Use in S.I. and fuel engines, LPG & Natural gas - Properties - Use in S.I. and C.I. Engines.

UNIT-V

VEGETABLE OILS: Properties - Esterification - Performance in Engines.

FUEL QUALITY: Fuel quality standards for Automotive Engines - Lead free gasolines, low and ultra -low sulphur diesels, LPG, CNG, and Biodiesels.

TEXT BOOKS:

1. Internal combustion engines by V . Ganesan, Tata McGraw Hill book cop. 2007
2. Richard L.Bechtold, Automotive Fuels Guide Book, SAE Publications,1997.

REFERENCES:

1. Osamu Hirao and Richard K.Pefley, Present and Future Automotive Fuels, John Wiley and sons, 1988.
2. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

AUTOMOTIVE AIR CONDITIONING SYSTEMS (Elective –I)
(15D33103)

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 etc. – HVAC equipment , recovery and charging. Air routing system service.

TEXTBOOK:
2) Tom Birch, “Automotive Heating and Air Conditioning” Pearson Education Inc., 2003.
3) Boyce H. Dwiggins, Jack Erjavec., “Automotive Heating and Air-Conditioning”, Delmer publisher.,2001.
4) William H Crouse and Donald L Anglin, “Automotive air conditioning”, McGraw - Hill Inc., 1990

REFERENCES
1) Goings. L.F., “Automotive air conditioning”, American Technical services, 1974
2) Paul Weiser, “Automotive air conditioning”, Reston Publishing Co Inc., 1990.
3) MacDonald, K.L., “Automotive air conditioning”, Theodore Audel series, 1978.
4) James D. Halderman, “Automotive Heating, Ventilation, and Air Conditioning Systems”, Pearson Education Inc., 2004.
5) SAE paper No: 931121,900084, 850040,931137,870029 etc.
6) Vehicle service manuals.

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ALTERNATIVE FUELS AND PROPULSION SYSTEMS (Elective –I)
(15D33104)

UNIT I ALCOHOLS AS FUELS
Alternative fuels. Availability of different alternative fuels for engines. Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission Characteristics in engines. Issues & limitation in alcohols

UNIT II VEGETABLE OILS AS FUELS
Vegetable oils and their important properties. Methods of using vegetable oils – Blending, preheating, Transesterification and emulsification – Performance, combustion and emission Characteristics in diesel engines. Issues & limitation in Vegetable Oils

UNIT III HYDROGEN AS ENGINE FUEL
Hydrogen – Properties, problems, Production methods, storage and safety aspects. Issues & limitation in Hydrogen. Methods of using hydrogen in engines. Performance, combustion and emission Characteristics in engines.

UNIT IV BIOGAS, NATURAL GAS AND LPG AS FUELS
Biogas, Natural gas and LPG – Properties and production methods. CO_2 and H_2S scrubbing in Biogas, Modifications required for use in Engines- Performance, combustion and emission Characteristics in engines. Issues & limitation in Gaseous fuels.

UNIT V HYBRID AND ELECTRIC VEHICLES
Hybrid and Electric vehicle – Layout, Merits, demerits and components, Electronic control system – Different configurations of Hybrid vehicles. Power split device. Energy regeneration. High energy and power density batteries – Introduction to PEM Fuel cell.

REFERENCES
1. Ayhan Demirbas, ' **Biodiesel A Realistic Fuel Alternative for Diesel Engines',** Springer-Verlag London Limited 2008,ISBN-13: 9781846289941
2. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, **The Biodiesel Handbook,** AOCS Press Champaign, Illinois 2005.
3. Richard L Bechtold P.E., **Alternative Fuels Guide book,** Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.
4. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).
5. Science direct Journals (**Biomass & Bio energy, Fuels, Energy, Energy conversion Management, Hydrogen Energy**, etc.) on biofuels.

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

TURBO MACHINES (Elective –I)
(15D33105)

Unit – I:

Fundamentals of Turbo machines: Classification, Applications Thermodynamic analysis; Isentropic flow, Energy transfer; Efficiencies; static and Stagnation conditions; continuity equation; Euler's flow through variable cross sectional area; unsteady flow in turbo machines.

Unit –II:

Steam Nozzles: Effect of back – pressure on the analysis; Design of nozzles.

Steam Turbines of C & C –D nozzles : Impulse Turbines: work done and velocity triangles; Efficiencies; Constant Reaction Blading; Design of blade passages, angles and height; Secondary flow; leakage losses; Thermodynamic analysis of steam turbines.

Unit – III:

Gas Dynamics: Fundamentals thermodynamic concepts; Isentropic conditions; Mach number and Area – Velocity relation; Dynamic pressure; normal shock relations for perfect gas; supersonic flow, oblique shock waves ; normal shock recovery ; detached shocks ; Aerofoil theory.

Centrifugal Compressor: Types; Velocity triangles and efficiencies; Blade passage design; Diffuser and pressure recovery; slip factor; stanitz and stodolas formulae; Effect of inlet mach number; Prewirl; performance.

Unit – IV:

Axial Flow Compressors: Flow analysis, work and velocity triangles ; Efficiencies; Thermodynamic analysis; stage pressure rise ; Degree of reaction ; stage loading ; general design, effect of velocity incidence ; performance.

Cascade Analysis: Geometry and Terminology; Blade forces, Efficiency; losses; free and forced vortex blades.

Unit – V:

Axial Flow Gas Turbines: Work done; velocity triangles and efficiencies; thermodynamic flow analysis; degree of reaction; Zweifels relation; Design cascade analysis – Soderberg – Hawthrone – ainley-correlations; secondary flow; Free-vortex blades; Blade angles for variable degree of reaction; Actuator disc theory; stresses in blades; Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance.

REFERENCES:

1) Fundamentals of Turbo machines – Shephard
2) Practise on Turbomachines – G. Gopalakrishnan & D. Prithviraj, SciTech Publishers, Chennai.
3) Theory and practice of steam turbines – Kearton
4) Gas Turbines – Theory and practice – Zucrow
5) Elements of Gas Dynamics – Liepman and Roshkow
6) Elements of Gas Dynamics – Yahya
7) Turbines, Pumps, Compressors – Yahya
8) Axial Flow Compressors – Horlock.
9) Gas Turbines- Cohen, Roger & Sarvanamuttu

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER **L P C**
4 - 4

THEORY OF FUELS AND LUBRICANTS (Elective –I)
(15D33106)

UNIT I MANUFACTURE OF FUELS AND LUBRICANTS
Structure of petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

UNIT II THEORY OF LUBRICATION
Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elasto hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system.

UNIT III PROPERTIES AND TESTING OF LUBRICANTS
Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, synthetic lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease.

UNIT IV PROPERTIES AND TESTING OF FUELS
Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc.

UNIT V ADDITIVES FOR LUBRICANTS AND FUELS
Additive - mechanism, requirements of additive, petrol fuel additives, diesel fuel additives – Additives and additive mechanism, for lubricants. Introduction to Nano fluids

TEXT BOOKS:
1. Ganesan.V., “Internal Combustion Engineering”, Tata McGraw-Hill Publishing Co., New Delhi, 2003.
2. M.L. Mathur, R.P.Sharma “A course in internal combustion engines”, Dhanpatrai publication, 2003.
3. Obert.E.F “Internal Combustion Engineering and Air Pollution”, International book Co., 1988.

REFERENCES
1. Brame, J.S.S. and King, J.G. – Fuels – Solids, Liquids, Gaseous.
2. Francis, W – Fuels and Fuel Technology, Vol. I & II
3. Hobson, G.D. & Pohl.W- Modern Petroleum Technology
4. A.R.Lansdown – Lubrication – A practical guide to lubricant selection – Pergamon press – 1982.
5. Raymond.C.Gunther – Lubrication – Chilton Book Co., - 1971.

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

AUTOMOBILE AIR POLLUTION AND ENVIRONMENT (Elective –II)
(15D33107)

UNIT-I

Introduction: Vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution.

UNIT-II

Pollutant Formation in SI Engines: Pollutant formation in SI Engines, mechanism of HC and CO formation in four stroke and two stroke SI engines, NOx formation in SI engines, effects of design and operating variables on emission formation, control of evaporative emission. Two stroke engine pollution.

UNIT-III

Pollutant Formation in CI Engines: Pollutant formation in CI engines, smoke and particulate emissions in CI engines, effects of design and operating variables on CI engine emissions. Nox formation an.d control.-Noise pollution from automobiles, measurement and standards.

UN1T-IV

Control of Emissions from SI and CI Engines: Design of engine, optimum selection of operating variables for control of emissions, EGR, Thermal reactors, secondary air injection, catalytic converters, catalysts, fuel modifications, fiiel cells, Two stroke engine pollution control.

UNIT-V

Measurement Techniques Emission Standards and Test Procedure:
Orsat Apparatus, NDIR, FID, Chemiluminescent analyzers, Gas Chromatograph, smoke meters, emission standards, driving cycles - USA, Japan, Euro and India. Test procedures - ECE, FTP Tests. SHED Test - chassis dynamometers, dilution tunnels.

REFERENCES:

1. Paul Degobert, Automobiles and Pollution, SAE International ISBN-1-56091-563-3, 1991.
2. Ganesan, V- Internal Combustion Engines- Tata McGraw-Hill Co - 2003.
3. SAE Transactions-Vehicle Emission - 1982 (3 volumes).
4. Obert. E.F.- Internal Combustion Engines, 1988.
5. Marco Nute- Emissions from two stroke engines, SAE Publication-1998.

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

JET PROPULSION & ROCKET ENGINEERING (Elective-II)
(15D33108)

UNIT-I

Turbo Jet Propulsion System:

Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery- compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

Flight Performance:

Forces acting on vehicle – Basic relations of motion – multi stage vehicles.

UNIT-II

Principles of Jet Propulsion and Rocketry:

Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

Nozzle Theory and Characteristics Parameters:

Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, A_c / A_t of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

UNIT-III

Aero Thermo Chemistry of the Combustion Products:

Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.

Solid Propulsion System:

Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates.

UNIT-IV

Solid propellant rocket engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end

burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.

Liquid Rocket Propulsion System:

Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

UNIT-V

Ramjet and Integral Rocket Ramjet Propulsion System:

Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

TEXT BOOKS:

1. Mechanics and Dynamics of Propulsion – Hill and Peterson
2. Rocket propulsion elements – Sutton

REFERENCES BOOKS:

1. Gas Turbines – Ganesan (TMH)
2. Gas Turbines & Propulsive Systems – Khajuria & Dubey (Dhanpatrai)
3. Rocket propulsion – Bevere
4. Jet propulsion – Nicholas Cumpsty

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M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ELECTRIC AND HYBRID VEHICLES (Elective-II)
(15D33109)

UNIT I NEED FOR ALTERNATIVE SYSTEM
Need of electric vehicles hybrid vehicles – comparative study of diesel, petrol, pure electric and hybrid vehicles. Limitations of electric vehicles. Specification of some electric and hybrid vehicles

UNIT II ENERGY SOURCES : BATTERIES AND FUEL CELLS
Battery Parameters-Power requirement of electric vehicles- Different types of batteries - Lead acid-Nickel based-Sodium based-Lithium based- Metal Air based. Battery charging- Charger design-Quick charging devices- Battery Modeling. Different type of energy storage – Solar, wind, compressed fluid.
Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series-water management in the PEM fuel cell- Thermal Management of the PEM fuel cell

UNIT III PROPULSION MOTORS AND CONTROLLERS
Characteristic of permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers.

UNIT IV VEHICLE DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES
Aerodynamic-Rolling resistance- Transmission efficiency- Vehicle mass- Electric vehicle chassis and Body design considerations- Heating and cooling systems- Controllers- Power steering- Tyre choice-Wing Mirror, Aerials and Luggage racks

UNIT V HYBRID VEHICLES
Types of Hybrid- Series, parallel, split – parallel, series - parallel - Advantages and Disadvantages. Power split device – Energy Management System - Design consideration - Economy of hybrid vehicles

TEXT BOOKS:
1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2. Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
3. Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press,2005

REFERENCES:
1. Ron HodKinson, “ light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005
2. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

PRODUCTION OF AUTOMOBILE COMPONENTS (Elective-II)
(15D33110)

UNIT I CASTING
Sand casting of cylinder block and liners - Centrifugal casting of flywheel, piston rings, bearing bushes, and liners, permanent mould casting of piston, pressure die casting of carburetor and other small auto parts. Melting practice of alloys

UNIT II MACHINING
Special consideration of machining of various components such as flywheel, piston rings, bearing bushes, and liners. Machining of connecting rods - crank shaft - cam shaft - piston - piston pin – valve - front and rear axle housing - fly wheel - Honing of cylinder bores - Copy turning and profile grinding machines.

UNIT III FORMING PROCESS
Forging materials - process flow chart, forging of valves, connecting rod, crank shaft, cam shaft, propeller shaft, transmission gear blanks, steering column. Extrusions: Basic process steps, extrusion of transmission shaft, housing spindle, steering worm blanks, piston pin and valve tappets. Hydro forming - Process, hydro forming of manifold and comparison with conventional methods- Hydro forming of tail lamp housing – forming of wheel disc and rims. Stretch forming - Process, stretch forming of auto body panels –Super plastic alloys for auto body panels.

UNIT IV POWDER METALLURGY AND PROCESSING OF PLASTICS
Powder metallurgy process, process variables, Manufacture of friction lining materials for clutches and brakes – plastics-raw material –automobile components – molding – injection, compression and blow – PU foam molding - Machining of plastics.

UNIT V RECENT TRENDS IN MANUFACTURING OF AUTO COMPONENTS
Powder injection molding - Production of aluminum MMC liners for engine blocks - Plasma spray coated engine blocks and valves - Recent developments in auto body panel forming –Squeeze Casting of pistons - aluminum composite brake rotors. Sinter diffusion bonded idler sprocket – gas injection molding of window channel – cast con process for auto parts.

TEXT BOOK
1. Heldt.P.M., " High Speed Combustion Engines ", Oxford Publishing Co., New York, 1990.

REFERENCES
1. Haslehurst.S.E., " Manufacturing Technology ", ELBS, London, 1990.
2. Rusinoff, " Forging and Forming of metals ", D.B. Taraporevala Son & Co. Pvt Ltd., Mumbai, 1995.
3. Sabroff.A.M. & Others, "Forging Materials & Processes ", Reinhold Book Corporation, New York, 1988.
4. Upton, "Pressure Die Casting ", Pergamon Press, 1985.
5. High Velocity "Forming of Metals ", ASTME, prentice Hall of India (P) Ltd., New Delhi, 1990
6. HMT handbook

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

I- SEMESTER	**L**	**P**	**C**
	0	**4**	**2**

"Performance Testing of Internal Combustion Engines" Lab
(15D33111)

1. Heat balance sheet on comet engine
2. Performance test on NIYO engine.
3. Retardation test on Black stone engine
4. Optimum cooling water rate on Texvel engine.
5. Morse test on 4-stroke multi cylinder Ambassador Engine.
6. Performance test on the Tata-sumo engine.
7. Measurements of octane number.
8. Measurement of exhaust emission by using five Exhaust gas analyzers.

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EFFECTIVE FROM THE YEAR 2015-16

M.Tech - ADVANCED I.C. ENGINES

II - SEMESTER:

Subject Code	SUBJECT	L	P	C
15D33201	Combustion in I.C. Engines	4	-	4
15D31202	Convective Heat & Mass Transfer	4	-	4
15D31204	Advanced Fluid Mechanics	4	-	4
15D33202	Engine Emissions and Control	4	-	4
	ELECTIVE-III	4	-	4
15D33203	Super Charging & Scavenging.			
15D33204	Vehicle Maintenance			
15D33205	Engine Management Systems			
15D33206	Instrumentation and Experimental Techniques			
	ELECTIVE-IV	4	-	4
15D33207	Automotive Aerodynamics			
15D33208	Vehicle Control Systems			
15D33209	Manufacturing and Testing of I.C. Engines and Components			
15D33210	Automotive Safety			
15D54201	Research Methodology (Audit Course)			
15D33211	"Testing of Combustion & Emissions of Internal Combustion Engines" Lab	0	4	2
TOTAL		**24**	**4**	**26**

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M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

COMBUSTION IN I.C. ENGINES

(15D33201)

UNIT-I

Combustion Principles: Thermodynamics, concepts of combustion - Combustion equations, heat of combustion Theoretical flame temperature, chemical equilibrium and dissociation. Chemical Kinetics**:** Theories of Combustion, Pre-flame reactions, Reaction rates, Laminar and Turbulent Flame Propagation in engines.

UNIT-II

Measurement of Thermo- Physical properties, instruments for measuring temperature, pressure and flow, use of intelligent instruments for physical variables.

UNIT-III

Combustion in S.I. Engines: Initiation of combustion, flame velocities, normal and abnormal combustion, knocking combustion, pre-ignition, knock and engine variables.
Features and design consideration of combustion chambers in S.I. Engines, stratified charge combustion, concepts of lean burn engines, heat release correlations.

UNIT-IV

Combustion in C.I. Engines: Various stages of combustion, vaporization of fuel droplets and spray formation, air motion, swirl, squish, tumble flow, velocities, swirl measurement, and delay period correlations. Diesel knocks and engine variables in C.I. Engines, features and design considerations of combustion chambers, heat release correlations.

UNIT-V

Combustion in Gas Turbine Flame stability, re-circulation zone and requirements. Combustion chamber configuration, materials.

TEXT BOOKS:

1. Ramalingam, K.K., Internal Combustion Engines, Scitech Publications (India) Pvt.Ltd, 2000
3. Internal combustion engines by V . Ganesan, Tata McGraw Hill book cop. 2007
4. Mathur M.L., and Sharma, R.P., A course in Internal Combustion Engines, Dhanpat Rai Publications Pvt.

REFERENCES:

1. John B.Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book, 1998. New Delhi -2,1993.
2. Obert, E.F.,Internal Combustion Engine and Air Pollution, International Text Books: Publishers, 1983.
3. Cohen, H,Rogers,G,E.C. and Saravanamutto, H.I.H., Gas Turbine Theory, Longman Group Ltd.,1980.
4. Khajuria & Dubey - Gas Turbines and jet Propulsive system, Dhanpat Rai Publications Pvt.Ltd., New Delhi - 2.
5. Doeblin, measurements system application and design, McGraw Hill, 1978.

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

CONVECTIVE HEAT &MASS TRANSFER
(Common to R&A/C & Advanced I.C. Engines)
(15D31202)

CONVECTIVE HEAT TRANSFER:

UNIT-I

Introduction to convection, review of conservation equations - Forced convection in laminar flow - Exact and approximate solutions of Boundary layer energy equation for plane isothermal plate in longitudinal flow - problems.

UNIT-II

Forced convection heat transfer in laminar tube flow - forced convection in turbulent flow – Internal Flows-Correlations-Problems. Approximate analysis of laminar free convective heat transfer on a vertical plate-external flows-correlations-problems.

UNIT-III

Boiling and condensation: Analysis of film condensation on a vertical surface – pool boiling - forced convection boiling inside tubes - problems.

MASS TRANSFER:

UNIT-IV

Definitions of concentration and velocities relevant to mass transfer, Fick's law, species conservation equation in different forms. Steady state diffusion in dilute solutions in stationary media, transient diffusion in dilute solutions in stationary media, one dimensional non dilute diffusion in gases with one component stationary.

UNIT-V

Convective mass transfer - governing equations-forced diffusion from flat plate- Dimension less correlation’s for mass transfer. Simultaneous heat and mass transfer - analogy between heat, mass and momentum transfer.

REFERENCES BOOKS:

1. Heat transfer - J. P. Holman.
2. Heat and Mass transfer- R.C. Sachdeva
3. Convective Heat and Mass transfer-Kays.
4. Heat and Mass transfer - V.Gupta and I.Srinivasan - Tata Mc.Graw Hill

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ADVANCED FLUID MECHANICS
(Common to R&A/C & Advanced I.C. Engines)
(15D31204)

UNIT - I

Basic concepts: Continuum hypothesis – Eulerian and Lagrangian descriptions. Derivation of general differential equations – continuity momentum and energy of incompressible flow-Navier Stokes equation for Viscous Fluids (Rectangular Co-Ordinate Systems)-Euler's equations for ideal fluids-Bernoulli's equations (one dimensional) – applications

UNIT - II

Laminar Flow Viscous Incompressible Fluids: Flow similarity – Reynolds number, flow between parallel flat plates, couette-flow, plane poiseuille flow, Hagen – poiseuille flow.

Laminar boundary layer: Boundary layer concept, Prandtl's approximations, Blassius solution for a flat plate without pressure gradient – momentum integral equation – Von-Kerman integral relation – Pohlhausen method of obtaining approximate solutions. Displacement thickness,momentum thickness and energy thickness.Boundary layer separation and control, Kerman's integral equation.

UNIT - III

Introduction to turbulence: Origin of turbulence, nature of turbulent flow – Reynolds equations and Reynolds stresses, velocity profile.

Compressible Fluid Flow Basics: Mach number, Flow pattern in compressible flow, classification of compressible flow, isentropic flow, stagnation properties.

UNIT - IV

Gas Dynamics: Compressible flow through ducts and nozzles – area velocity relations. Flow through convergent and convergent divergent nozzles. Real nozzles flow at design conditions. Introduction to normal compression shock – normal shock relations. Introduction to Fanno Raleigh equations.

UNIT - V

Flow in ducts with friction: Fanno line, adiabatic constant area- Flow of perfect gas, chocking due to friction in constant area flow- Introduction to constant area flow with heat transfer (Raleigh line)

REFERENCE:

1. Yuan S.W. “Foundations of Fluid Mechanics”, Prentice Hall – Eastern economy edition 1983
2. Zucrwo M.J. and Hoffman J.D. “Gas Dynamics”, Vol-I & Vol-II, John Wiley and Sons Inc. 1977
3. Yahya S.M. “Fundamentals of Compressible Flow”, - Wiley Eastern
4. Young, Munsen and Okiisyi, “ A Brief Introduction to Fluid Mechanics” 2nd Edition, John Wiley 2000.
5. Frank.M.White, “ Fluid Mechanics 5th Edn – McGraw Hill 2005.

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ENGINE EMISSIONS AND CONTROL
(15D33202)

UNIT-I

Pollution - Engines and Turbines: Atmospheric pollution from piston engines and gas turbines, global warming. Pollutant Formation: Formation of oxides of nitrogen, carbon monoxide, hydrocarbon, aldehydes and Smoke Particulate emission, effects of pollutions on environment.

UNIT-II

Pollution Measurements: Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke measurement, noise pollution, measurement and control.

UNIT-III

Control of Engine Pollution: Engine component, fuel modification, evaporative emission control, EGR, air injection thermal reactors, in cylinder control of pollution, catalytic converters, application of microprocessor in emission control.

UNIT-IV

Driving Cycles and Emission Standards: Use of driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards. Steady state and test cycle - Transient test cycle.

UNIT-V

Effect of High Pressure Injection on Soot Formation Process**:** High Pressure Injection - Experimental apparatus and measuring principles - Measurement of Non-Evaporating spray – Measurement of Evaporating sprays and flame. Diesel Soot Suppression: Soot Suppression by kind and content of fuel additives - Under various operating conditions - Effect of combustion chamber type and swirl ratio. Simultaneous Reduction of Soot and NO_x

TEXT BOOKS:

1. Ernest, S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.
2. Crouse William, Automotive Emission Control, Gregg Division10/e, (SIE) 2006.
3. A Text Book of Air Pollution by M.N. Rao Tata McGraw Hill book cop.

REFERENCES:

1. Obert, E.F., Internal Combustion Engines and air Pollution, in text Educational Publishers, 1980.
2. George, Springer and Donald J.Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum Press, 1972.
3. Satora, Yasuhiro Iton Gutaka Higuchi and Tateo Nagai, SAE - 901608.
4. SW Cootes and G.G.Lassanska, SAE - 901597.
5. G.Greeves and CHT Wang, SAE – 810260.

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

SUPER CHARGING & SCAVENGING (Elective-III)
(15D33203)

UNIT – I
SUPERCHARGING
Objectives-Effects on engine performance-engine modification required-Thermo dynamics of Mechanical supercharging and Turbocharging-Turbocharging methods Engine exhaust manifolds arrangements.

UNIT-II
SUPERCHARGERS
Types of compressors – Positive displacement blowers – Centrifugal compressors – Performance characteristic curves – Suitability for engine application – Surging Matching of supercharger compressor and Engine Matching of compressor, Turbine Engine

UNIT-III
SCAVENGING OF TWO STROKE ENGINES
Peculiarties of two stroke cycle engines – Classification of scavenging systems-Mixture control through Reed value induction – Charging Processes in two stroke cycle engine Terminologies-Shankey diagram-Relation between scavenging terms-scavenging terms scavenging modeling-perfect displacement, Perfect mixing-Complex scavenging models.

UNIT-IV
PORTS AND MUFFLER DESIGN
Porting – Design considerations-Design of intake and Exhaust Systems-Tuning.

UNIT-V
EXPERIMENTAL METHODS
Experimental techniques for evaluating scavenging-Firing engine tests-Non firing engine tests – Port flow characteristics-Kadenacy systems-Orbital engine combustion system, Sonic system.

REFERENCES:
1. Orbet, E.F., Internal Combustion Engines and Air Pollution, Intext Education Publishers, 1980.
2. Richard Stone, Internal Combustion Engines, SAE, 1992.
3. Vincent, E.T., Supercharging the I.C.Engine, McGraw-Hill
4. Waston, N. and Jonota, M.S., Turbocharging the I.C. Engine, MacMillan Co., 1982.
5. Schweitzer, P.H., Scavenging of Two Stroke Cycle Diesel Engine, MacMillan Co.,
6. John B.Heywood, Two Stroke Cycle Engine, SAE Publications, 1997.

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

VEHICLE MAINTENANCE (Elective-III)
(15D33204)

UNIT I MAINTENANCE TOOL, SHOP, SCHEDULE, RECORDS
Standard tool set, torque wrenches, compression and vacuum gauges, engine analyzer and scanner, computerized wheel alignment and balancing, gauges for engine tune up and pollution measurement, spark plug cleaner, cylinder re boring machine, fuel injection calibration machine. Importance of maintenance. Schedule and unscheduled maintenance. Scope of maintenance. Equipment downtime. Vehicle inspection. Reports. Log books. Trip sheet. Lay out and requirements of maintenance shop.

UNIT II POWER PLANT REPAIR AND OVERHAULING
Dismantling of power plant and its components. Cleaning methods. Inspection and checking. Repair and reconditioning methods for all engine components. Maintenance of ignition system, fuel injection system, cooling system,- lubrication system. Power plant trouble shooting chart.

UNIT III MAINTENANCE, REPAIR AND OVERHAULING OF THE CHASSIS
Maintenance, servicing and repair of clutch, fluid coupling, gearbox, torque converter, propeller shaft. Maintenance of front axle, rear axle, brakes, steering systems.

UNIT IV MAINTENANCE AND REPAIR OF VEHICLE BODY
Body panel tools for repairing. Tinkering and painting. Use of soldering, metalloid paste. Tyre maintenance, metallic, plastics

UNIT V MAINTENANCE AND REPAIR OF ELECTRICAL SYSTEMS 7
Care, maintenance, testing and trouble shooting of battery, starter motor, dynamo, alternator and regulator. Transistorized regulator problems.

TEXTBOOK:
1. A.W.Judge, Motor Vehicle Servicing, 3rd Edition, Pitman Paperpack, London , 1969.
2. W.Crouse, Everyday Automobile repair, Intl.student edition, TMH, New Delhi, 1986.
3. Ernest Venk., Edward spicer, Automotive maintenance and trouble shooting, D.B. Taraporevala Sons, Bombay, 1963

REFERENCES:
1. Stator Abbey, Automotive steering, braking and suspension overhaul, pitman publishing, London, 1971.
2. Frazee, fledell, Spicer,-Automobile collision Work, American technical publications, Chicago, 1953.
3. John Dolce, Fleet maintenance, Mcgraw Hill, Newyork, 1984
4. A,W.Judge, Maintenance of high speed diesel engines, Chapman Hall Ltd., London, 1956.
5. V.L.Maleev, Diesel Engine operation and maintenance, McGraw Hill Book CO., Newyork, 1995.
6. Vehicle servicing manuals.
7. Ernest Venk., Edward spicer, Automotive maintenance and trouble shooting, D.B. Taraporevala

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M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ENGINE MANAGEMENT SYSTEMS (Elective-III)
(15D33205)

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS
Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control.
Switches, active resistors, Transistors, Current mirrors/amplifiers, Voltage and current references, Comparator, Multiplier. Amplifier, filters, A/D and D/A converters.

UNIT II SENSORS AND ACTUATORS
Inductive, Hall Effect, thermistor, piezo electric, piezoresistive, based sensors. Throttle position, mass air flow, crank shaft position, cam position, engine speed sensor, exhaust oxygen level (two step, linear lambda and wideband), knock, manifold temperature and pressure sensors. Solenoid, relay(four and five pin), stepper motor.

UNIT III SI ENGINE MANAGEMENT
Layout and working of SI engine management systems. Group and sequential injection techniques. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless (BREAKERLESS) electronic ignition system, Electronic spark timing control.

UNIT IV CI ENGINE MANAGEMENT
Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Electronically controlled Unit Injection system. Common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve.

UNIT V DIGITAL ENGINE CONTROL SYSTEM
Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop and closed loop control – Integrated engine control system, Electromagnetic compatibility – EMI Suppression techniques – Electronic dash board instruments – Onboard diagnosis system.

TEXT BOOKS:
1. Understanding Automotive Electronics William B Ribbens, SAE 1998
2. Automobile Electronics by Eric Chowanietz SAE

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

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M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

INSTRUMENTATION AND EXPERIMENTAL TECHNIQUES (Elective-III)

(15D33206)

UNIT I MEASUREMENT SYSTEMS
Static and Dynamic Measurement systems-importance of measurement system – methods of measurement -applications - characteristics of measuring system-static and dynamic characteristics of measuring system – Analysis of experimental detail, Error analysis-types of errors-limiting errors

UNIT II TRANSDUCERS, MODIFIERS AND TERMINATING DEVICES
Transducers for Automotive Applications – Amplifiers-Classifications and application in automobile – filters -types – Data Acquisition system - analog and digital type DAS- Indicators, Printers and display device –Signal Analyzing with example of automobile applications.

UNIT III MECHANICAL MEASUREMENT
Instrumentation for Measuring Weight, Force, torque , pressure, power, temperature, fluid flow and special methods , vibration piezo electric effect, rotational speed .Measuring Velocity, acceleration and angular motion with respect to automobile applications

UNIT IV ENGINE EXPERIMENTAL TECHNIQUES
I.S Code for Engine testing – Instrumentation for performance testing of engine, Instrumentation for Research and development, Instrumentation for noise, vibration, in cylinder gas flow, flame temperature Dynamic Cylinder pressure measurements.

UNIT V VEHICLE EXPERIMENTAL TECHNIQUES
Laboratory tests- test tracks - Endurance Tests- crash tests- wind tunnel tests- Dynamic cornering fatigue, dynamic radial fatigue tests – procedure, bending moment and radial load calculations. Impact test – road hazard impact test for wheel and tyre assemblies, test procedures, failure criteria and performance criteria. Bumpers - types of tests, pendulum test, fixed collision barrier test, procedure, performance criteria. Air and hydraulic brake test, air brake actuator, valves test, performance requirements.

TEXTBOOK:
1. J.G. Giles, ‘Engine and Vehicle Testing’, Illiffe books Ltd., London,1968.
2. T.G. Beckwith and Buck, ‘Mechanical Measurements’, Oxford and IBH Publishing House, New Delhi, 1995

REFERENCES
1. A.W. Judge, ‘Engineering Precision Measurement’, Chapman and Hall Ltd, Essex Street W.C.,1951,
2. D.Patambis, ‘Principle of Industrial Instrumentation’, Tata McGraw Hill Publishing Co, New Delhi, 1990.
3. Rangan, Sharma and Mani, ‘Instrumentation Devices and systems’, Tata McGraw Hill Publishing Co., Ltd., 1990

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

AUTOMOTIVE AERODYNAMICS (Elective-IV)
(15D33207)

UNIT I INTRODUCTION
Scope – historical development trends – Fundamentals of fluid mechanics – Flow phenomenon related to vehicles – External & Internal flow problems – Resistance to vehicle motion – Fuel consumption and performance – Significance of vehicle aerodynamics.

UNIT II AERODYNAMIC DRAG OF CABS
Car as a bluff body – Flow field around car – drag force – types of drag force – analysis of aerodynamic drag – drag coefficient of cars – strategies for aerodynamic development – low drag profiles.

UNIT III SHAPE OPTIMIZATION OF CABS
Front end modification – front and rear wind shield angle – Boat tailing – Hatch back, fast back and square back – Dust flow patterns at the rear – Effect of gap configuration – effect of fasteners

UNIT IV VEHICLE HANDLING
Force and moments – Origin, calculation, effects and characteristics. Side wind problems – vehicle dynamic under side winds – Dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles.

UNIT V WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS
Principles of wind tunnel technology – Types, Stress with scale models – full scale wind tunnels – measurement techniques – Equipment and transducers – road testing methods. Introduction to CFD.

TEXTBOOK:
1. Hucho, W.H., Aerodynamics of Road vehicles, Butterworths Co. Ltd., 4th Edition, SAE 1998.

REFERENCES:
1. Pope, A, Wind Tunnel Testing, John Wiley & Sons, 2nd Edn., New York, 1994.
2. Automotive Aerodynamics: Update SP-706, SAE, 1987.
3. Vehicle Aerodynamics, SP-1145, SAE, 1996.

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER **L P C**
4 - 4

VEHICLE CONTROL SYSTEMS (Elective-IV)
(15D33208)

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 tilt table 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. Ljubo Vlacic, Michel Parent, Fumio Harashima, “Intelligent Vehicle Technologies”, Butterworth-Heinemann publications, Oxford, 2001.

REFERENCES:
1. Crouse, W.H. & Anglin, D.L., “Automotive Mechanics”, Intl. Student edition, 9th edition, TMH, New Delhi, 2002.
2. William B.Ribbens -Understanding Automotive Electronics, 5th edition, Butter worth Heinemann Woburn,1998.
3. Bosch, “Automotive HandBook”, 6th edition, SAE, 2004.
4. Internet References

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DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

MANUFACTURING AND TESTING OF I.C. ENGINES AND COMPONENTS
(Elective-IV)
(15D33209)

UNIT-I
CYLINDER BLOCK AND CYLINDER HEAD
Casting practice and special requirements, materials, machining, methods of testing.

UNIT-II
PISTON ASSEMBLY
Types, requirement, casting, forging, squeeze casting, materials, maching, testing, manufacture and testing of fuel and ignition system, bimetallic pistons, articulated pistons.

UNIT-III
CONNECTING ROD, CRANKSHAFT AND CAMSHAFT
Requirements, materials, forging practice, machining, balancing of crankshaft, testing, Manufacturing of fuel system parts such as carburetor, gasoline injection system and diesel injection parts.

Unit-IV
COMPUTER INTEGRATED MANUFACTURING
Integration of CAD, CAM and Business function CIM – Networking, CNC Programming for machining of I.C. Engines Components.

Unit-V
QUALITY AND TESTING
Introduction to ISO 9000, ISO 14000, QS9000. its importance, BIS codes for testing various types of engines, equipments, required, instrumentation, computer aided engine testing, metrology for manufacturing I.C. Engine Components

REFERENCES :

1. Grover, M.P., CAD/CAM, Prentice Hall of India Ltd., 1985.
2. Heldt, P.M.High speed internal combustion engines, Oxford & IBH Publishing Co., 1960.
3. Judge, A.W. Testing of High speed internal combustion engines, chapman & Hall., 1960.
4. Richard, W., Heine Carl R.Loper Jr.and Philip, C., Rosenthal, Principles of Metal Casting, McGraw Hill Book Co., 1980.

5. IS: 1602 – 1960 Code for testing of variable speed internal combustion engines for Automobile Purposes, 1966.
6. SAE Handbook, 1994.
7. P.Radhakrishnan and S.Subramaniayn, CAD/CAM/CIM, New Age International(P) Limited Publishers, 1977.
8. Mikett P.Groover, Automation, production systems and Computer-integrated Manufacturing Printice Hall of India Private Limited, 1999.

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

AUTOMOTIVE SAFETY (Elective-IV)
(15D33210)

UNIT I INTRODUCTION
Automotive safety – Introduction, Types. Active safety: driving safety, conditional safety, perceptibility safety, operating safety- Passive safety: exterior safety, interior safety-Advantages

UNIT II PASSIVE SAFETY CONCEPTS
Design of body for safety, engine location, deceleration of vehicle, passenger compartment, deceleration on impact with stationary and movable obstacles. Deformation behavior of vehicle body. Concept of crumble zone, Safety Cage.

UNIT III PASSIVE SAFETY EQUIPMENTS
Regulations, Seat belt, automatic seat belt tightener system and importance , collapsible steering column, tiltable steering column with advantages , air bags, Designing aspcets of automotive bumpers and materials for bumpers.

UNIT IV ACTIVE SAFETY AND CONVENIENCE SYSTEM
Antiskid braking system, Secondary braking system. Stability Control. Steering and mirror adjustment, central locking system, Garage door opening system, tyre pressure control system, rain sensor system, environment information system, manual and automated wiper system, Driver alertness detection system.

UNIT V VEHICLE INTEGRATION AND NAVIGATION SYSTEM
Intelligent vision system, Adaptive cruise control, Warning systems, Collision Avoidance systems Vehicle Network system. Global Positioning System. Road Network, Navigation System. Telematics.

TEXT BOOK:
1. Bosch, “Automotive HandBook”, 6th edition, SAE, 2004.

REFERENCES:
1. J.Powloski - “Vehicle Body Engineering” - Business books limited, London - 1969.
2. Ronald.K.Jurgen - “Automotive Electronics Handbook” - Second edition- McGraw-Hill Inc., - 1999.
3. ARAI Safety standards

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech - ADVANCED I.C. ENGINES

II- SEMESTER	**L**	**P**	**C**
	0	**4**	**2**

"Testing of Combustion & Emission of Internal Combustion Engines" Lab (15D33211)

1. Performance test on computer controlled single cylinder 4 – stroke Diesel engine test rig.
2. Performance test on P-θ Diagram on computer controlled single cylinder 4- stroke Diesel Engine.
3. Heat balance sheet on Computerized controlled – stroke diesel Engine.
4. P-V Diagram on computerized controlled single cylinder 4 – stroke Engine.
5. Performance test on 2 – stroke reciprocating Air compressor.
6. Engine performance characteristics on Anil engine.
7. Performance test on Black stone Engine.
8. Valve timing Diagram on 2-stroke C.I. Engine.

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs with effect from AY 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED INTERNAL COMBUSTION ENGINES

I SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D31102	Advanced Thermodynamics	PC	3	0	0	3
2	21D33101	Advanced Heat & Mass Transfer	PC	3	0	0	3
3	**Professional Elective – I**						
	21D33102	Combustion and Emission in Engines	PE	3	0	0	3
	21D33103	Engine Auxiliary Systems					
	21D33104	Electronic Engine Management System					
4	**Professional Elective – II**						
	21D33105	Alternative Fuels for I.C. Engines	PE	3	0	0	3
	21D33106	Theory of Fuels & Lubricants					
	21D33107	Advanced Fluid Mechanics					
5	21D11109	Research Methodology and IPR	MC	2	0	0	2
6	21D11110	English for Research Paper Writing	AC	2	0	0	0
	21D11111	Value Education					
	21D11112	Pedagogy Studies					
7	21D33108	Performance Testing of Internal Combustion Engine Lab	PC	0	0	4	2
8	21D33109	Advanced Heat Transfer Lab	PC	0	0	4	2
Total				**16**	**00**	**08**	**18**

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DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED INTERNAL COMBUSTION ENGINES

II SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D33201	Internal Combustion Engine Design.	PC	3	0	0	3
2	21D33202	Engine Pollution and Control	PC	3	0	0	3
3	**Professional Elective – III**						
	21D33203	Hybrid and Electric Vehicles	PE	3	0	0	3
	21D33204	Autotronics and Vehicle Intelligence					
	21D33205	Automotive Electrical and Electronics					
4	**Professional Elective – IV**						
	21D33206	Computational Fluid Dynamics for Thermal Systems	PE	3	0	0	3
	21D33207	Automotive Safety					
	21D33208	Supercharging and Scavenging					
5	21D11209	Technical Seminar	PR	0	0	4	2
6	21D11210	Disaster Management	AC	2	0	0	0
	21D11211	Constitution of India					
	21D11212	Stress Management by Yoga					
7	21D33209	Testing of Combustion & Emission of IC Engines Laboratory	PC	0	0	4	2
8	21D33210	Engine Design Laboratory	PC	0	0	4	2
Total				**14**	**00**	**12**	**18**

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs with effect from AY 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED INTERNAL COMBUSTION ENGINES

I SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D31103	Conduction and Radiation Heat Transfer	PC	3	0	0	3
2	21D32101	Renewable Energy Sources	PC	3	0	0	3
3	**Professional Elective – I**						
	21D32102	Energy Management	PE	3	0	0	3
	21D32103	Direct Energy Conversion Systems					
	21D32104	Applied Solar Energy Engineering					
4	**Professional Elective – II**						
	21D32105	Reliability & Safety Engineering	PE	3	0	0	3
	21D32106	Data Acquisition and Processing System					
	21D32107	Design of Heat Transfer Equipment					
5	21D11109	Research Methodology and IPR	MC	2	0	0	2
6	21D11110	English for Research Paper Writing	AC	2	0	0	0
	21D11111	Value Education					
	21D11112	Pedagogy Studies					
7	21D32108	Energy Utilization Lab	PC	0	0	4	2
8	21D32109	Thermal Energy Lab	PC	0	0	4	2
Total				**16**	**00**	**08**	**18**

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs with effect from AY 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED INTERNAL COMBUSTION ENGINES

II SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D32201	Energy Conservation and Audit	PC	3	0	0	3
2	21D32202	Energy Efficient Electrical Systems	PC	3	0	0	3
3	**Professional Elective – III**						
	21D32203	Waste Heat Recovery Systems	PE	3	0	0	3
	21D32204	Total Quality Management					
	21D32205	Solar Refrigeration & Air Conditioning					
4	**Professional Elective – IV**						
	21D32206	Design of Wind Energy Systems	PE	3	0	0	3
	21D32207	Energy Resources					
	21D32208	Optimization of Engineering Design					
5	21D11209	Technical Seminar	PR	0	0	4	2
6	21D11210	Disaster Management	AC	2	0	0	0
	21D11211	Constitution of India					
	21D11212	Stress Management by Yoga					
7	21D32209	Energy Operations Lab	PC	0	0	4	2
8	21D32210	Renewable Energy Systems Laboratory	PC	0	0	4	2
Total				**14**	**00**	**12**	**18**

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DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED INTERNAL COMBUSTION ENGINES

III SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	**Professional Elective – V**						
	21D33301	Fuel cell technology	PE	3	0	0	3
	21D33302	Specialty Engines					
	21D33303	Environmental Engineering and Pollution control					
2	**Open Elective**						
	21D30301	Mechatronics	OE	3	0	0	3
3	21D33304	Dissertation Phase – I	PR	0	0	20	10
4	21D00301	Co-Curricular Activities	PR				2
Total				**06**	**00**	**20**	**18**

IV SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D33401	Dissertation Phase – II	PR	0	0	32	16
Total				**00**	**00**	**32**	**16**

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D31102	ADVANCED THERMODYNAMICS(21D31102)	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

1. The objective of this course is to prepare students to effectively solve theoretical and applied thermodynamics problems that are directly applicable to situations faced in research and industry.
2. Significant emphasis is placed on the integration of recent thermodynamics-related research into the traditional resources in order to foster critical analysis of current work as it relates to fundamental principles.

Course Outcomes (CO): Student will be able to

1. Describe and calculate thermodynamic properties.
2. Apply the laws of statistical and classical thermodynamics to chemically reactive systems, kinetics, and combustion.
3. Relate course principles to solve problems regarding gas turbines, combustion, refrigeration, and solar energy.

UNIT – I	THERMODYNAMIC PROPERTYRELATIONS AND AVAILABILITY ANALYSIS	Lecture Hrs:9

Thermodynamic relations: Differential relation for U,H,G&F-Maxwell relations. Generalized relation for Cp, Cv ,K, B-relations for internal energy and enthalpy-the various Tds equation-clapeyron equation-gas tables-enthalpy and internal energy- pressure ratio-volume ratio-change of entropy-Introduction to third law of thermodynamics.

EXERGY:

Introduction-availability of heat –availability of a closed system-availability function of the closed system-availability of steady flow system- availability function of open system.

IRREVERSIBILITY:

Introduction-irreversibility for closed and open system-steady flow process effectiveness-second law analysis of the power plant.

UNIT – II	NON REACTIVE GAS MIXTURES	Lecture Hrs:9

Introduction-basic definitions for gas mixtures-PVT relations ship for mixtures of ideal gases-properties of mixtures of ideal gases-entropy change due to mixing – mixtures of perfect gases at different initial pressure and temperatures.

UNIT – III	CHEMICAL THERMODYNAMICS AND EQUILIBRIUM	Lecture Hrs:9

Thermo chemistry-Firstlawanalysisofreactingsystems-Adiabaticflametemperature–entropy change of reacting systems- Second law analysis of reacting systems- Criterion for reaction equilibrium. Equilibriumconstantforgaseousmixtures-evaluationofequilibriumcomposition.

UNIT – IV	ANALYSIS OF VAPOUR POWER & VAPOUR COMPRESSION REFRIGERATION CYCLES	Lecture Hrs:9

Introduction-the carnotvapor cycle-rankine cycle-effects of operation condition on efficiency-principles of increasing the thermal efficiency- method of increasing thermal efficiency. Super – critical and ultra-super-critical Rankine cycle.

Vapour compression refrigeration Systems, Analysis of vapour refrigeration systems, Commonly used refrigerants.

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
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UNIT – V	**ANALYSIS OF GAS POWER CYCLES**	**Lecture Hrs:9**

IC Engines : Air standard Otto, Diesel and Dual cycle
Gas turbines: Air standard Brayton cycle, Effect of reheat, inter cooling and regeneration**,** Combined gas and vapour power cycles.

Textbooks:

1. Kenneth Wark Jt. m, Advanced Thermodynamics for Engineers, McGrew – Hill Inc.,1995.
2. Bejan,A.,AdvancedEngineeringThermodynamics,JohnWileyandCons,1988.
3. Holman, J.P., Thermodynamics, Fourth Edition, McGraw–HillInc.,1988.
4. Fundamentals of Engineering Thermodynamics by V.Babu

Reference Books:

1. Smith,J.M.andVanNess., H.C.,Introductionto Chemical Engineering Thermodynamics, Fourth Edition, McGraw– HillInc.,1987.
2. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical andStatistical Thermodynamics,ThirdEdition,JohnWileyandSons, 1991.
3. Sears,F.W.andSalingerG.I.,Thermodynamics,KineticTheoryandStatisticalThermodynamics, ThirdEdition,NarosaPublishingHouse,NewDelhi,1993.
4. DeHotf, R.T., Thermodynamics in Materials Science, McGraw – Hill Inc., 1993. Rao,Y.V.C.Postulational and Statistical Thermodynamics, Allied Publisher Limited, NewDelhi,1999

Online Learning Resources:

1. https://nptel.ac.in/courses/103/103/103103162/
2. https://onlinecourses.nptel.ac.in/noc20_ch03/preview

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33101	ADVANCED HEAT AND MASS TRANSFER (21D33101)	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows.
- To analyse the thermal analysis and sizing of heat exchangers and to learn the heat transfer coefficient for compact heat exchanges**.**
- To achieve an understanding of the basic concepts of phase change processes and mass transfer.

Course Outcomes (CO): Student will be able to

- On successful completion of this course the student will be able to apply the law of thermodynamics to engines.

UNIT – I **Lecture Hrs:9**

Introduction of three modes of heat transfer, steady, unsteady state heat transfer process, governing equations and boundary conditions
Two dimensional steady state conduction, Heating and cooling of bodies with negligible internal resistance, sudden changes in the surface temperature of infinite plates, cylinders and semi-infinite bodies -simple problems.

UNIT – II **Lecture Hrs:9**

Introduction to convection, review of conservation equations
Forced convection heat transfer in laminar tube flow - forced convection in turbulent flow – Internal Flows-Correlations-Problems. Approximate analysis of laminar free convective heat transfer on a vertical plate-external flows- correlations-problems.

UNIT – III **Lecture Hrs:9**

Boiling and condensation: Analysis of film condensation on a vertical surface – pool boiling - forced convection boiling inside tubes - problems.

UNIT – IV **Lecture Hrs:9**

Review of the thermal radiation - gas radiation, mean beam length exchange between gas volume and black enclosure, heat exchange between gas volume and gray enclosure, problems
Solar radiation: Radiation properties of environment, effect of radiation on temperature measurement, the radiation heat transfer coefficient, problems.

UNIT – V **Lecture Hrs:9**

Definitions of concentration and velocities relevant to mass transfer, Fick's law, species conservation equation in different forms. Steady state diffusion in dilute solutions in stationary media, transient diffusion in dilute solutions in stationary media, one dimensional non dilute diffusion in gases with one component stationary.

Textbooks:

1. YunusA.Cengal, Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.
2. Holman.J.P, Heat Transfer, Tata McGraw Hill, 2002.
3. Heat and Mass transfer- R.C. Sachdeva

Reference Books:
1. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985 2. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley &Sons,2002. 3. Nag.P.K, Heat Transfer, Tata McGraw-Hill, 2002 4. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004 Yadav, R., 5. Heat and Mass Transfer, Central Publishing House, 1995.
Online Learning Resources:
https://nptel.ac.in/courses/112/101/112101097/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33102	COMBUSTIONANDEMISSIONINENGINES (21D33102)	L	T	P	C
Semester	I	PE – I	3	0	0	3

Course Objectives:

- Understandcombustion insparkignition andcompressionignitionengines.
- Toidentifythenatureandextentoftheproblemofpollutantformationandcontrolininternalcombustione ngines.

Course Outcomes (CO): Student will be able to

- Understandthe concept ofthecombustioninengines.

UNIT - I	COMBUSTION PRINCIPLES	Lecture Hrs:9

Combustion –Combustion equations, heatof combustion–chemical equilibrium and Dissociation-Theories of Combustion - Flammability Limits - Reaction rates - Laminar and Turbulent FlamePropagationinEngines.Introductiontosprayformationandcharacterization.

UNIT – II	COMBUSTION IN S.I.ENGINES	Lecture Hrs:9

Stagesofcombustion,normalandabnormalcombustion,knocking,variablesaffectingknock,Featuresanddesig nconsiderationof combustionchambers.Flamestructureandspeed,Cyclicvariations,Leanburncombustion,Stratifiedchargeco mbustionsystems.Heatreleasecorrelations.

UNIT – III	COMBUSTION IN C.I.ENGINES	Lecture Hrs:9

Stagesofcombustion,vapourisationoffueldropletsandsprayformation,airmotion,swirlmeasurement,knocka ndenginevariables,Featuresanddesignconsiderationsof combustion chambers, delay period correlations, heat release correlations, Influence of the injection system oncombustion,Directand indirectinjection systems.

UNIT – IV	COMBUSTION IN GASTURBINES	Lecture Hrs:9

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

UNIT – V	EMISSIONS	Lecture Hrs:9

Carbon Monoxide, Unburnt Hydrocarbons, Oxides of Nitrogen, Particulate Matter and Smoke — sources.Emission control measures for SI and CI engines.Effect of emissions on environment andhumanbeings.

Textbooks:

1. B.P.PundirEngine CombustionandEmission, Narosa Publishing House,2011.
2. Cohen,H,Rogers,G,E.C,andSaravanamuttoo,H.I.H.,GasTurbineTheory,LongmanGroupLtd.,198 0.
3. DomkundwarV,ACourseinInternal CombustionEngines, DhanpatRai&Co.(P)Ltd,2002.
4. Ganesan, V, Internal CombustionEngines, Tata McGrawHillBookCo., 2003.

Reference Books:

1. JohnB. Heywood,Internal CombustionEngineFundamentals,McGrawHill Book, 1998.
2. Mathur,M.L.,andSharma,R.P.,ACourseinInternalCombustionEngines,DhanpatRaiPublicationsPvt. New Delhi-2,1993.
3. Obert,E.F.,InternalCombustionEngineandAirPollution,InternationalTextBookPublishers,1983.
4. RajputR.K.InternalCombustionEngines,LaxmiPublications (P)Ltd,2006.
5. Ramalingam, K.K.,InternalCombustionEngines,SciTechPublications(India)Pvt.Ltd.,2004.

6. WillardW.Pulkrabek,EngineeringFundamentalsoftheInternalCombustionEngines,SecondEdition,Pearson PrenticeHall,2007,

Online Learning Resources:

https://onlinecourses.nptel.ac.in/noc21_me69/preview

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33103	ENGINE AUXILIARY SYSTEMS (21D33103) PE - I	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Know about the concept of carburation.
- Know about the concept of gasoline injection and ignition systems.
- Understand diesel fuel injection.
- Understand the design and construction of various intake systems and its components.
- Know about the various types and the concepts of lubrication and cooling system.

Course Outcomes (CO): Student will be able to

- Understand the concept of air fuel mixture and the various components in the carburetor
- Understand the types of gasoline fuel injection , and the mechanism of ignition system.
- Know about the various techniques involved in diesel fuel injection.
- Understand the various design constraints and the types of intake and exhaust manifolds.
- Understand the concept and various types of lubrication and cooling system

UNIT – I	CARBURETION	Lecture Hrs:9

Properties of air-petrol mixtures, Mixture requirements for steady state and transient operation, Mixture formation studies of volatile fuels, Design of elementary carburetor, Chokes, Effects of altitude on carburetion, Carburetor for 2-stroke and 4-stroke engines, Carburetor systems for emission control.

UNIT – II	GASOLINE INJECTION AND IGNITION SYSTEMS	Lecture Hrs:9

Petrol Injection, Pneumatic and Electronic Fuel Injection Systems types. Ignition system requirements, Timing, Ignition Systems, Breaker mechanism and Spark plugs, Factors affecting energy requirement of the ignition system, Factors affecting spark plug operation, Electronic Ignition Systems.

UNIT – III	DIESEL FUEL INJECTION	Lecture Hrs:9

Factors influencing fuel spray atomization, Penetration and Dispersion of diesel and heavy oils and their properties, Rate and duration of injection, Fuel line hydraulics, Fuel pump, Injectors.

UNIT – IV	MANIFOLDS AND MIXTURE DISTRIBUTION	Lecture Hrs:9

Intake system components, Discharge coefficient, Pressure drop, Air filter, Intake manifold, Connecting pipe, Exhaust system components, Exhaust manifold and exhaust pipe, Spark arresters, Waste heat recovery, Exhaust mufflers, Type of mufflers, exhaust manifold expansion.

UNIT – V	LUBRICATION AND COOLING SYSTEMS	Lecture Hrs:9

Lubricants, Lubricating systems, Lubrication of piston rings, Bearings, Oil consumption, Oil cooling. Heat transfer coefficients, liquid and air cooled engines, Coolants, Additives and lubricity improvers, Concept of adiabatic engines.

Textbooks:

1. Ramalingam,K.K, Internal Combustion Engine, Scitech Publication (India) Pvt.Ltd.2000.
2. Domkundwar, V.M, A Course in Internal Combustion Engines, DhanpatRai and Co., 1999.
3. Mathur,M.L., and Sharma,R.P., A Course in Internal Combustion Engines,

DhanpatRaiPublications (P) Ltd., 1998.
4. Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill Book Co., 1995.

Reference Books:

1. Duffy Smith, Auto Fuel Systems, The Good Heart Willcox Company Inc., Publishers, 1987.
2. Edward F, Obert, Internal Combustion Engines and Air Pollution, Intext Education Publishers, 1980.

Online Learning Resources

https://nptel.ac.in/courses/112/103/112103262/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33104	ELECTRONIC ENGINEMANAGEMENT SYSTEMS (21D33104) PE - I	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Togive anin-depthknowledge ofvarious sensorsusedinenginemanagement
- Togivean overviewofdifferenttypes of fuelinjection andignitionsystems
- Toknowthelatest technological advancementsin vehicle power plant

Course Outcomes (CO): Student will be able to

- UnderstandaboutElectronicEngineManagementSystems

UNIT – I	BASICS OF ELECTRONICS	Lecture Hrs:9

Semiconductors, Transistors, Amplifiers, Integrated circuits — Analog and Digital, Logic Gates,Microcontrollers,AnalogtoDigitalandDigitaltoAnalogConverters,Steppermotors.

UNIT – II	SENSORS	Lecture Hrs:9

Sensors-
Airflow,Pressure,Temperature,Speed,ExhaustgasOxygen,KnockCamshaftandPosition,Principleo foperation,constructionandcharacteristics.

UNIT – III	IGNITION SYSTEMS	Lecture Hrs:9

Ignitionfundamentals, Solid state ignition systems, High energy ignition systems, Electronic sparktiming and control. Combined ignition and fuel management systems.Dwell angle calculation, Ignitiontimingcalculation.

UNIT – IV	GASOLINE INJECTION SYSTEMS	Lecture Hrs:9

Open loop and closed loop systems, Mono-point, Multi-point, Direct injection systems and Air assistedsystemsPrinciplesandFeatures,Idlespeed,lambda,knockandsparktimingcontrol

UNIT – V	DIESEL INJECTION SYSTEMS	Lecture Hrs:9

Heatrelease,controloffuelinjection,Inlineinjectionpump,RotaryPumpandInjector–Constructionand principle of operation, Electronic control, Common rail, unit injector systems and unit pumpsystems–Constructionandprincipleofoperation.

Textbooks:

1. BoschTechnical InstructionBooklets.
2. DieselEngineManagement,Fourth Edition,Robert Bosch,NewnessPublications,2005.
3. DuffySmith,Auto FuelSystems,TheGoodHeart-WilcoxCompanyInc.,Publishers,1992.
4. EricChowanietz, AutomobileElectronics,SAEPublications, 1995.

Reference Books:

1. Gasoline Engine Management,ThirdEdition,RobertBosch,BentleyPublications, 2004.
2. RobertN.Brady,AutomotiveComputersandDigitalInstrumentation,PrenticeHall,1988.
3. TomDenton,AutomotiveElectricalandElectronicSystems,4th Edition,TaylorandFrancisGroup, 2004.
4. WilliamB.Ribbens,UnderstandingAutomotiveElectronics,SixthEdition,ElsevierInc,2002.

Online Learning Resources:

1. https://nptel.ac.in/content/storage2/courses/112104033/pdf_lecture/lecture27.pdf

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33105	ALTERNATIVE FUELS FOR I.C. ENGINES (21D33105)	L	T	P	C
Semester	I	PE – II	3	0	0	3

Course Objectives:

- Togive anin-depthknowledge ofvarious fuels and alternative fuels used in IC Engines

Course Outcomes (CO): Student will be able to

- Understandabout the usage of alternative fuels in IC Engines and its effect on environment

UNIT – I	Introduction	Lecture Hrs:9

solid fuels, gases fuels, liquid fuels, chemical structure of petroleum, petroleum refining process, important requisite qualities of engine fuels, SAE rating of fuels.

UNIT – II	FUELS	Lecture Hrs:9

Availability and Suitability to Piston Engines, Concept of conventional fuels, potential alternative fuels - Ethanol, Methanol, DEE/DME - Hydrogen, LPG, Natural gas, Producer gas, Bio gas and Vegetable oils - Use in I.C.Engines-Merits and Demerits of various fuels.

UNIT – III	ALCOHOL FUELS	Lecture Hrs:9

Properties as engine fuels - Performance in S.I.Engines - Alcohol & Gasoline blends - Flexible Fuel Vehicle -Reformed alcohols.
Alcohols in C.I. Engines - Emulsions - Dual fuel systems -Spark assisted diesel engines - Surface ignition engines - Ignition accelerators - Manufacture of alcohol fuels.

UNIT – IV	GASEOUS FUELS	Lecture Hrs:9

Hydrogen - Properties - Use in C.I Engines - Use in S.I Engines - Storage methods - Safety precautions -Production methods.
Production of Producer gas and bio gas - Raw materials - Gasification - Properties - Cleaning up the gas -Use in S.I. and fuel engines, LPG & Natural gas - Properties - Use in S.I. and C.I. Engines.

UNIT – V	VEGETABLE OILS	Lecture Hrs:9

Properties - Esterification - Performance in Engines.
FUEL QUALITY:Fuel quality standards for Automotive Engines - Lead free gasolines, low and ultra -low sulphur diesels, LPG, CNG, and Biodiesels.

Textbooks:

1. Internal combustion engines by V .Ganesan, Tata McGraw Hill book cop. 2007
2. Richard L.Bechtold, Automotive Fuels Guide Book, SAE Publications,1997.

Reference Books:

1. Osamu Hirao and Richard K.Pefley, Present and Future Automotive Fuels, John Wiley and sons, 1988.
2. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.

Online Learning Resources:

1. https://nptel.ac.in/courses/103/102/103102026/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33106	THEORY OF FUELS AND LUBRICANTS (21D33106) PE – II	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Togive anin-depthknowledge ofvarious fuels and Lubricants used in I.C.Engines.
- Togivean overviewofdifferenttypes of properties of Lubricants

Course Outcomes (CO): Student will be able to

- Understandaboutmanufacturing and testing of fuels and Lubricants.

UNIT – I	MANUFACTURE OF FUELS AND LUBRICANTS	Lecture Hrs:9

Structure of petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

UNIT – II	THEORY OF LUBRICATION	Lecture Hrs:9

Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elasto hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system.

UNIT – III	PROPERTIES AND TESTING OF LUBRICANTS	Lecture Hrs:9

Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, synthetic lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease.

UNIT – IV	PROPERTIES AND TESTING OF FUELS	Lecture Hrs:9

Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc.

UNIT – V	ADDITIVES FOR LUBRICANTS AND FUELS	Lecture Hrs:9

Additive - mechanism, requirements of additive, petrol fuel additives, diesel fuel additives – Additives and additive mechanism, for lubricants. Introduction to Nano fluids

Textbooks:

1. Ganesan.V, “Internal Combustion Engineering”, Tata McGraw-Hill Publishing Co., New Delhi, 2003.
2. M.L. Mathur, R.P.Sharma “A course in internal combustion engines”, Dhanpatrai publication, 2003.
3. Obert.E.F “Internal Combustion Engineering and Air Pollution”, International book Co., 1988.

Reference Books:

1. Brame, J.S.S. and King, J.G. – Fuels – Solids, Liquids, Gaseous.
2. Francis, W – Fuels and Fuel Technology, Vol. I & II
3. Hobson, G.D. &Pohl.W- Modern Petroleum Technology
4. A.R.Lansdown–Lubrication–A practical guide to lubricant selection – Pergamon press – 1982.
5. Raymond.C.Gunther – Lubrication – Chilton Book Co., - 1971.
6. GasolineEngineManagement,ThirdEdition,RobertBosch,BentleyPublications, 2004.

Online Learning Resources:

1. https://nptel.ac.in/courses/103/102/103102022/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES

DEPARTMENT OF MECHANICAL ENGINEERING

(ADVANCED INTERNAL COMBUSTION ENGINES)

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33107	ADVANCED FLUID MECHANICS (21D33107) PE – II	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Establish an understanding of the fundamental concepts of fluid mechanics.
- Understand and apply the potential flow equations to basic flows.
- Understand and apply the differential equations of fluid mechanics including the ability to applyand understand the impact of assumptions made in the analysis.
- Understand the boundary layer concepts with respect to fluid flow
- Understand and apply the compressible flow equations.

Course Outcomes (CO): Student will be able to

- Apply knowledge of mathematics, science and engineering.
- Derive the governing equations of fluid flow and applying them to simple flow problems.
- Emphasizing the mathematical formulation of various flow problems.
- Apply the boundary layer concept to the fluid flow problems.

UNIT – I

Basic concepts: Continuum hypothesis - Eulerian and Lagrangian descriptions. Derivation of general differential equations – continuity momentum and energy of incompressible flow-Navier Stokes equation for Viscous Fluids (Rectangular Co-Ordinate Systems)-Euler's equations for ideal fluids-Bernoulli's equations (one dimensional) – applications

UNIT – II

Laminar Flow Viscous Incompressible Fluids: Flow similarity – Reynolds number, flow between parallel flat plates, couette-flow, plane poiseuille flow, Hagen – poiseuille flow.
Laminar boundary layer: Boundary layer concept, Prandtl's approximations, Blassius solution for a flat plate without pressure gradient – momentum integral equation – Von-Kerman integral relation – Pohlhausen method of obtaining approximate solutions. Displacement thickness,momentum thickness and energy thickness. Boundary layer separation and control.

UNIT – III

Turbulent Flow: Reynolds experiment, Frictional Loss in pipe flow, Resistance of smooth and rough pipes.
Compressible Flow: Mach number, Propagation of pressure waves or disturbances in compression fluid, Velocity of sound or pressure wave in a fluid, Stagnation properties,

UNIT – IV

Gas Dynamics: Compressible flow through ducts and nozzles – area velocity relations. Flow through convergent and convergent divergent nozzles. Real nozzles flow at design conditions. Introduction to normal compression shock – normal shock relations. Introduction to Fanno Raleigh equations.

UNIT – V

Flow in ducts with friction: Fanno line, adiabatic constant area- Flow of perfect gas, chocking due to friction in constant area flow- Introduction to constant area flow with heat transfer (Raleigh line)

Textbooks:

1. Yuan S.W. "Foundations of Fluid Mechanics", Prentice Hall – Eastern economy edition 1983
2. Zucrwo M.J. and Hoffman J.D. "Gas Dynamics", Vol-I & Vol-II, John Wiley and Sons Inc. 1977
3. Yahya S.M. "Fundamentals of Compressible Flow", - Wiley Eastern
4. Young, Munsen and Okiisyi, " A Brief Introduction to Fluid Mechanics" 2nd Edition, John Wiley 2000.
5. Frank.M.White, " Fluid Mechanics 5th Edn – McGraw Hill 2005.

Reference Books:

1. Yuan S.W. "Foundations of Fluid Mechanics", Prentice Hall – Eastern economy edition 1983
2. Zucrwo M.J. and Hoffman J.D. "Gas Dynamics", Vol-I & Vol-II, John Wiley and Sons Inc. 1977
3. Yahya S.M. "Fundamentals of Compressible Flow", - Wiley Eastern
4. Young, Munsen and Okiisyi, " A Brief Introduction to Fluid Mechanics" 2nd Edition, John Wiley 2000.
5. Frank.M.White, " Fluid Mechanics 5th Edn – McGraw Hill 2005.

Online Learning Resources:

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DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33108	PERFORMANCE TESTING OF INTERNAL COMBUSTION ENGINES LABORATORY (21D33108)	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

- Tounderstandthe behaviorofIC Enginesatdifferentoperatingconditions

Course Outcomes (CO):

- Onsuccessful completion ofthiscoursethestudentwill beable tohave hands onexperience in Operation,testingofengines.

List of Experiments:

1. Heat balance sheet on comet engine
2. Performance test on NIYO engine.
3. Retardation test on Black stone engine
4. Optimum cooling water rate on Texvel engine.
5. Morse test on 4-stroke multi cylinder Ambassador Engine.
6. Performance test on the Tata-sumo engine.
7. Measurements of octane number.
8. Measurement of exhaust emission by using five Exhaust gas analyzers.

Online learning resources/Virtual labs:

https://nptel.ac.in/content/storage2/courses/112104033/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33109	ADVANCED HEAT TRANSFER LABORATORY (21D33109)	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

- Understand the various forms of heat transfer and their applications in real life problems.
- Analyze different methods to calculate the heat transfer coefficient in various heat transfer problems.
- Analyze the theoretical knowledge and apply it in conducting experiments in the forms of heat transfer.

Course Outcomes (CO):

- Perform steady state conduction experiments to estimate thermal conductivity of different materials for plane, cylindrical and spherical geometries
- Perform the transient heat conduction experiment and obtain variation of temperature along the length of the pin fin.
- Estimate heat transfer coefficients in forced convection, free convection and determine effectiveness of heat exchangers
- Perform radiation experiments:determine surface emissivity of a test plane and Stefan-Boltzmann's constant and compare with theoretical values
- Estimate heat transfer coefficients in condensation, boiling and effectiveness of heat pipe

List of Experiments:

1. Determine heat transfer in shell and tube heat exchanger(Parallel and Counter).
2. Thermal conductivity of insulating material through lagged pipe apparatus
3. To phenomenon of critical radius of insulation
4. Thermal Conductivity of metal rod (conductor).
5. Determine effectiveness of finned tube heat exchanger by LMTD Method
6. Experiment on Transient Heat Conduction
7. Heat transfer coefficient in forced convection.
8. Heat transfer coefficient in natural convection
9. Experiment on Parallel and counter flow heat exchanger.
10. Emissivity of a gray body through Emissivity apparatus.
11. Experiment on Stefan Boltzman Apparatus.
12. Heat transfer in drop and film wise condensation.
13. Pin Fin apparatus (Forced convection)
14. Study of heat pipe and its demonstration.
15. Study of Two – Phase flow.

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

CourseCode	21D33201	INTERNALCOMBUSTIONENGINEDESIGN (21D33201)	L	T	P	C
Semester	II		3	0	0	3

CourseObjectives:

- Toprovidethebasic groundingonthepistonenginedesignphilosophy.

CourseOutcomes(CO): Student willbeableto

- Thestudentwouldhavegainedaninsight/understandingontherudimentsofpistonenginedesign philosophy as a prelude to higher level design activities for variedapplications.

UNIT–I	GENERAL DESIGN PRINCIPLES	Lecture Hrs:9

Principleofsimilitude,Choiceofmaterial,Stress,FatigueandNoise, Vibration andHarshnessconsiderations(NVH)

UNIT–II	DESIGNSPECIFICSOFTWO-STROKEENGINESYSTEMS	Lecture Hrs:9

Scavenging,Arrangementandsizingofports,pistonassembly,intakeandexhaustsystem,applicationtoautomotivegasolineengines.

UNIT–III	DESIGNOF MAJOR COMPONENTS	Lecture Hrs:9

Pistonsystem,Powercylindersystem,Connectingrodassembly,Crankshaftsystem,ValveGearing,Stressanalyses

UNIT–IV	DESIGNOFOTHERCOMPONENTS/SUBSYSTEMS	Lecture Hrs:9

Inlet and exhaust manifolds, cylinder block, cylinder-head, crankcase. Design aspects of enginemountings,gaskets,bearings.Basics ofignition,lubricationandcoolingsystemdesign. Introductiontodesignofcatalytic converters, particulate traps andEGR systems.

UNIT–V	DESIGN OF FUEL FLOW SYSTEMS	Lecture Hrs:9

Design of injectors systems, carburettors and fuel supply systems in CI Engines

Textbooks:

1. AnIntroductiontoEngineTestingandDevelopment,RichardD.Atkids,SAEInternational, USA,2009.
2. Design andSimulation ofFour-StrokeEngines,GordonP.Blair,SocietyofAutomotiveEngineers,Inc.,USA,1999.
3. Diesel Engine Reference Book, Second Edition, RodicaBaranescu and Bernard Challen(Editors),SocietyofAutomotiveEngineers,Inc.,USA,1999.
4. Engineering Design,A SystematicApproach,G.Pahl, W.BeltzJ.Fieldhusen and K.H.Grote,Springer
5. ModernEngineTechnologyfromAtoZ,RichardVanBasshuysenandFredSchafer,SAEInternational,USAandSiemensVDO,Germany,2007.
6. Springer–Verlag,Wien,Austria,2006.
7. VehicularEngineDesign,KevinL.Hoag,SAEInternational USA/

ReferenceBooks:

1. EngineeringFundamentalsoftheInternalCombustionEngine,WillardW.Pulkrabek,Second Edition,Prentice–HallofIndiaPvt.Ltd.,NewDelhi,2006.
2. InternalCombustionEngineDesign,A.KolchinandV.Demidov,MIRPublishers,Moscow,1984.
3. InternalCombustionEngineFundamentals,JohnB.Heywood,McGraw–

HillBookCompany,1988.
4. InternalCombustionEngineHand book:Basics,Components,Systemsand Perspectives,RichardVanBasshuysenandFredSchafer(Editors)SAEInternationalUSAandSiemes VDOAutomotive,Germany,2002.
5. IntroductiontoEngineValvetrains,YushuWang, SAE International,USA,2007.
6. Introduction to Internal Combustion Engines, Richard Stone, Fourth Edition SAEInternational,USAandMacmillanPress,2012.

OnlineLearningResources:

1.https://nptel.ac.in/courses/112/104/112104033/

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DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33202	ENGINE POLLUTION AND CONTROL (21D33202)	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- Understandeffectofvehiclepopulationandemittedpollutantsonhumanhealthandenvironmentandvarioustypesofemissions.
- Understandtheformationmechanismofvarioustypesofpollutantsfrom SIandCIengines.
- Conceivethesignificanceofemissioncontrolmethods.
- Understandtheconstructionandworkingofemissionmeasuringinstruments.
- Befamiliarwithemissionstandardsandtestprocedures.

Course Outcomes (CO): Student will be able to

- Analysetheimpact of vehiclepopulationonpollutionandtheeffectsHC,CO,CO2,NOX,smoke,particulates,leadandaldehydesonhealthandenvironment.
- Describetheeffectsoftransientoperationofvehicleonemissionsandtypesofemissions.Describetheformationmechanismof HC,CO,CO2,NOX,smoke,particulatesandaldehydesinSIandCIengines.
- Comprehendthefactorsthatleadtoglobalwarmingandtheissues.Analysethedesignandoperatingparametersonemissions.Describeaboutnoisepollution,measurementandcontrol.
- AwareofUS,Euro,JapanandIndianemissionnorms,standardsCVSsamplingandtestprocedures.Analysein-cylinderemissioncontrolmethodssuchasEGR,airinjection,fuelmodifications,waterinjection,ignitionandinjectiontiming.
- Describeengine-outemissioncontrolmethodsuchasthermalreactorsandcatalyticconverters.Describetheconstructionandworkingofemissionmeasuringinstrumentssuchas NDIR,FID,smokemetersChemi-luminescent analyserandgaschromatograph.Differentiatebetweentwostrokeandfourstrokeenginepollutions.

UNIT – I	POLLUTANT FORMATION-ENGINES AND TURBINES	Lecture Hrs:9

Atmosphericpollutionfrompistonenginesandgasturbines,Globalwarming.Formationofoxidesofnitrogen,Carbonmonoxide,Hydrocarbon,aldehydesandSmoke,Particulateemission,Effectsofpollutionsonenvironment.

UNIT – II	POLLUTIONMEASUREMENT	Lecture Hrs:9

Nondispersiveinfraredgasanalyzer,Gaschromatography,Chemi-luminescentanalyzerandflameionizationdetector,Smokemeasurement,Noisepollution,Measurementandcontrol.

UNIT – III	POLLUTIONCONTROL-INCYLINDERMETHODS	Lecture Hrs:9

Enginecomponent,Fuelmodification,Evaporativeemissioncontrol,EGR,Airinjection,WaterInjection,Applicationofmicroprocessorinemissioncontrol.

UNIT – IV	POLLUTIONCONTROLAFTERTREATMENT	Lecture Hrs:9

Thermalreactors,Catalyticconverters,&ParticulateTraps

UNIT – V	**CYCLESANDEMISSIONSTANDARDS**	**Lecture Hrs:9**
Useofdrivingcyclesforemissionmeasurement,Chassisdynamometer,CVSsystem,Nationaland Internationalemissionstandards.		
Textbooks:		
1.CrouseWilliam,AutomotiveEmissionControl,GreggDivision/ McGraw-Hill, 1980 2.Ernest,S.,Starkman,CombustionGeneratedAirPollutions,PlenumPress,1980.		
Reference Books:		
1. George,SpringerandDonaldJ.Patterson,Engineemissions,PollutantFormationandMeasurement,Plenumpress,1972. 2. Obert,E.F.InternalCombustionEnginesandAirPollution,IntextEducationalPublishers,1980.		
Online Learning Resources: 1. https://nptel.ac.in/courses/112/104/112104033/		

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DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED INTERNAL COMBUSTION ENGINES)

Course Code	21D33203	HYBRID AND ELECTRICVEHICLES (21D33203) PE – III	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- Understand working of Electric Vehicles and recent trends.
- Know-how & aptitude towards future trends in Hybrid Electric Vehicles.

Course Outcomes (CO): Student will be able to

- Familiarize on concepts of electric vehicle & performance of electric vehicles
- Gain knowledge on Electric Propulsion Systems & Generators
- Acquire the knowledge on hybrid electric drive train systems
- Gain knowledge on motor controllers and control systems & energy storages
- Attain the knowledge on Energy Storages -Fuel Cells & Solar Cars and Control systems.

UNIT – I	ELECTRIC VEHICLES	Lecture Hrs:9

Layout of an electric vehicle, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system.

UNIT – II	ELECTRIC PROPULSION SYSTEMS & GENERATORS	Lecture Hrs:9

DC motors, AC motors, permanent magnet motors, brushless DC and reluctance motors, Characteristics, regenerative braking. DC generators, AC generators, voltage and frequency regulations.

UNIT – III	HYBRID VEHICLES	Lecture Hrs:9

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, series and parallel hybrid electric drive train design

UNIT – IV	MOTOR CONTROLLERS AND CONTROL SYSTEMS & ENERGY STORAGES	Lecture Hrs:9

Control system principles, speed and torque control – DC motors and AC motors. Electromechanical batteries- types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, ultra-capacitors.

UNIT – V	FUEL CELLS & SOLAR CARS	Lecture Hrs:9

Fuel cell, construction, working, equations, possible fuel sources, fuel reformer, design. Solar carsphotovoltaic cells, tracking, efficiency and cost comparison.

Textbooks:

1. MehrdadEhsani, YiminGao, sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRS Press, 2014.
2. James Larminie and John Loury, “Electric Vehicle Technology-Explained”, John Wiley & Sons Ltd., 2013

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Reference Books:

1. SandeepDhameja, "Electric Vehicle Battery Systems", Butterworth –Heinemann, 2012.
2. Donwhite Consultant Incorporate – Handbook of EMI / EMC – Vol I – 2015
3. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2012
4. Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design", ButterworthHeinemann, 2012

Online Learning Resources:

1. https://nptel.ac.in/courses/108/103/108103009/

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DEPARTMENT OF MECHANICAL ENGINEERING
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Course Code	21D33204	AUTOTRONICS AND VEHICLE INTELLIGENCE (21D33204) PE – III	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- Understand working of automotivesensors.
- Know-how & aptitude towards future trends in Vehicleintelligence

Course Outcomes (CO): Student will be able to

- Tounderstandtheautomotiveelectronics
- Tounderstandthesensorsandtheirapplications
- Tostudy about theelectronicfuelinjectionandignitioncontrol
- Tointroducethedifferent vehicle systems
- Tobroadentheimportanceofvehicleintelligencesystem

UNIT – I	Automotive fundamentals	Lecture Hrs:9

Theengine-components-drivetrain-starting&chargingsystemsoperation-ignitionsystem-suspension systems-brakes-abs-steering system.

UNIT – II	Automotive sensors	Lecture Hrs:9

Temperaturesensor-gassensor-knocksensor-pressuresensor-flowsensor-torquesensor-crash sensor-speedsensorandaccelerationsensor-microsensor-smartsensor-operation,types,characteristics,advantagesandtheirapplications.

UNIT – III	Electronic fuel injection and ignition system	Lecture Hrs:9

Introduction-fuel system components-electronic fuel system-fuel injection-types-throttle bodyversus port injection-electronic control fuel injection-operation-different types-fuel injectors-idlespeedcontrol-continuousinjectionsystem-highpressuredieselfuelinjection-MPFI system-electronicignitionsystem-operation-types-electronicsparktimingcontrol.

UNIT – IV	Electric vehicles and hybrid vehicles	Lecture Hrs:9

Introduction-electricvehicledevelopment-systemlayout-basicsystemcomponents-electricbattery-solarcells-rapidchargingsystem-motordrivesystem-fuelcellelectricvehicle-hybrid vehicle-serieshybridvehicle-parallelhybrid vehicle-CNG electrichybridvehicle.

UNIT – V	Vehicle intelligence	Lecture Hrs:9

Introduction -basic structure-vision basedautonomous road vehicles-architecture for dynamicvision system - features-applications- a visual control system using image processing and fuzzytheory-anapplicationofmobilerobotvisiontoavehicleinformationsystem.-objectdetection,collisionwarningandavoidance systemlowtirepressurewarningsystem.

Textbooks:

1. Willium B. Ribbens,Understanding Automotive Electronics -Sixth edition Elsevier Science 2003
2. Ronald K.Jurgen, Sensors and Transducers - SAE 2003
3. Jack Erjavec, Robert Scharff, Automotive Technology - Delmar publications Inc 1992

Reference Books:

1. Ronald K.Jurgen, Electric and Hybrid-electric vehicles - SAE 2002
2. Ichiro Masaki, Vision-based Vehicle Guidance - Springer Verlag, Newyork 1992
3. Jay Webster, Class Room Manual For Automotive Service And System – Delmer

PublicationsInc 1995
Online Learning Resources: 1. https://nptel.ac.in/courses/107/106/107106080/ 2. https://www.delorenzoglobal.com/documenti/cataloghi/200117_AUTOTRONICS_2_ENG.pdf

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Course Code	21D33205	AUTOMOTIVE ELECTRICAL AND ELECTRONICS (21D33205) PE – III	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- Know about the fundamentals of batteries and accessories.
- Know about the mechanics of starting system.
- Understand the procedures for charging system.
- Understand the system of fundamentals of automotive electronics.
- Know the system of fuel, cooling and lubrication.

Course Outcomes (CO): Student will be able to

- Familiarize with lead acid battery and accessories.
- Acquire the knowledge of starting system.
- Develop the knowledge on charging system.
- Gain knowledge on automotive electronics.
- Gain the information about sensors and activators.

UNIT – I	BATTERIES AND ACCESSORIES	Lecture Hrs:9

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging. Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, headlight dazzling and preventive methods - Horn, wiper system and trafficator.

UNIT – II	STARTING SYSTEM	Lecture Hrs:9

Condition at starting, behavior of starter during starting, series motor and its characteristics,principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, starter switches.

UNIT – III	CHARGING SYSTEM	Lecture Hrs:9

Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout, Voltage and current regulators, compensated voltage regulator, alternatorsprinciple and constructional aspects and bridge rectifiers, new developments

UNIT – IV	FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS	Lecture Hrs:9

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

UNIT – V	SENSORS AND ACTUATORS	Lecture Hrs:9

Types of sensors: sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay.

Textbooks:

1. Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & New Press-reprint 2010.
2. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, reprint 2010.

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Reference Books:

1. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., NewDelhi, reprint 2011
2. Robert Bosch, "Automotive Hand Book", SAE (5th Edition), 2010.

Online Learning Resources:

1. https://nptel.ac.in/courses/108/102/108102121/

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Course Code	21D33206	COMPUTATIONALFLUIDDYNAMICSFOR THERMALSYSTEMS (21D33206) PE – IV	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion it will enable the students to understand the various discretization methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
- To develop finite volume discretized forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Equations &Navier Stokes Equations.

Course Outcomes (CO): Student will be able to

- Onsuccessfulcompletionofthiscoursethestudentwillbeabletoapplyconcept of CFD to analyse flow in thermal systems

UNIT – I	GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES	Lecture Hrs:9

Basics of Heat Transfer, Fluid flow — Mathematical description of fluid flow and heat transfer —Conservation of mass, momentum, energy and chemical species- Classification of partial differential equations — Initial and Boundary Conditions — Discretization techniques using finite difference methods — Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT – II	DIFFUSION PROCESSES: FINITE VOLUME METHOD	Lecture Hrs:9

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems — Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes

UNIT – III	CONVECTION –DIFFUSION PROCESSES: FINITE VOLUME METHOD	Lecture Hrs:9

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques–QUICK scheme.

UNIT – IV	FLOW PROCESSES: FINITE VOLUME METHOD	Lecture Hrs:9

Discretisation of incompressible flow equations–Pressure based algorithms,SIMPLE,SIMPLER&PISO algorithms

UNIT – V	TURBULENCE AND ITS MODELLING	Lecture Hrs:9

Description of turbulent flow, free turbulent flows, flat plate boundary layer and pipe flow. Algebraic Models, One equation model, k — ε & k — ω models Standard and High and Low Reynolds number models.

Textbooks:

1. Internal combustion engines by V .Ganesan, Tata McGraw Hill book cop. 2007
2. Richard L.Bechtold, Automotive Fuels Guide Book, SAE Publications,1997.

Reference Books:

1. Osamu Hirao and Richard K.Pefley, Present and Future Automotive Fuels, John Wiley and sons, 1988.

2. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.

Online resources:

1. https://nptel.ac.in/courses/112/105/112105045/

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Course Code	21D33207	AUTOMOTIVE SAFETY (21D33207)	L	T	P	C
Semester	II	PE – IV	3	0	0	3

Course Objectives:

- Understand the Design of the body for safety.
- Understand the various types of safety concepts.
- Understand the concept of scavenging in two stroke engines.
- Understand the design concept of safety equipment's.
- Understand the experimental methods for comfort and convenience system.

Course Outcomes (CO): Student will be able to

- Know about the basics about the vehicle.
- Understand the safety aspects in the vehicle
- Know and understand the various safety aspects
- To get the knowledge in sensors provided in the vehicle to avoid the crash andto detect the defects in the vehicle
- To know about the comfort and convenience system

UNIT – I	INTRODUCTION	Lecture Hrs:9

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, Safetysandwich construction.

UNIT – II	SAFETY CONCEPTS	Lecture Hrs:9

Active safety: Driving safety, Conditional safety, Perceptibility safety, Operating safety-Passive safety: Exterior safety, Interior safety, Deformation behaviour of vehicle body, Speed and acceleration characteristics of passenger compartment on impact.

UNIT – III	SAFETY EQUIPMENTS	Lecture Hrs:9

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, Antiskid braking system, Regenerative Braking System, Cruise Control, Adaptive Cruise Control Devices

UNIT – IV	COLLISION WARNING AND AVOIDANCE	Lecture Hrs:9

Collision warning system, Causes of rear end collision, Frontal object detection, ear vehicle object detection system, Object detection system with braking system interactions, Driver Fitness Detection.

UNIT – V	COMFORT AND CONVENIENCE SYSTEM	Lecture Hrs:9

Steering and mirror adjustment, Central locking system , Garage door opening system, Tyre pressure controlsystem, Rain sensor system, Environment information system, Manual and Automated Wiper System, GPS.

Textbooks:

1. Bosch - "Automotive Handbook" - 5th edition - SAE publication - 2000.

Reference Books:

1. J.Powloski - "Vehicle Body Engineering" - Business books limited, London - 1969.
2. Ronald.K.Jurgen-"Automotive Electronics Handbook" - Second edition- McGraw-Hill Inc., 1999.

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Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc20_de06/preview

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Course Code	21D33208	SUPERCHARGING AND SCAVENGING (21D33208)	L	T	P	C
Semester	II	PE – IV	3	0	0	3

Course Objectives:

- Understand the purpose of using supercharging.
- Understand the various types in supercharger.
- Understand the concept of scavenging in two stroke engines.
- Understand the design concept of ports and mufflers
- Understand the experimental methods for scavenging.

Course Outcomes (CO): Student will be able to

- Describe the effects on engine performance and engine modification.
- Describe the various types of compressors and blowers
- Know the classification of scavenging systems and charging processes in two stroke engines.
- Design of intake and exhaust systems.
- Analyze the experimental techniques for evaluating scavenging and port flow characteristics

UNIT – I	SUPERCHARGING	Lecture Hrs:9

Objectives - Effects on engine performance - engine modification required Thermodynamics of Mechanical Supercharging and Turbocharging - Turbocharging methods - Engine exhaust manifolds arrangements.

UNIT – II	SUPERCHARGERS	Lecture Hrs:9

Types of compressors - Positive displacement blowers - Centrifugal compressors - Performance characteristic curves - Suitability for engine application - Surging - Matching of supercharger compressor and Engine - Matching of compressor, Turbine, Engine.

UNIT – III	SCAVENGING OF TWO STROKE ENGINES	Lecture Hrs:9

Peculiarities of two stroke cycle engines - Classification of scavenging systems - Mixture control through Reed valve induction - Charging Processes in two stroke cycle engine - Terminologies - Shankey diagram - Relation between scavenging terms - scavenging modeling - Perfect displacement, Perfect mixing - Complex scavenging models.

UNIT – IV	PORTS AND MUFFLER DESIGN	Lecture Hrs:9

Porting - Design considerations - Design of Intake and Exhaust Systems - Tuning.

UNIT – V	EXPERIMENTAL METHOD	Lecture Hrs:9

Experimental techniques for evaluating scavenging - Firing engine tests - Non firing engine tests - Port flow characteristics - Kadenacy system - Orbital engine combustion system.

Textbooks:

1. Vincent,E.T., Supercharging the I.C.Engines, McGraw-Hill. 1943
2. Watson, N. and Janota, M.S., Turbocharging the I.C.Engine, MacMillan Co., 1982.
3. Schweitzer, P.H., Scavenging of Two Stroke Cycle Diesel Engine, MacMillan Co., 1956
4. John B.Heywood, Two Stroke Cycle Engine, SAE Publications, 1997.

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Reference Books:
1. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, 1980. 2. Richard Stone, Internal Combustion Engines, SAE, 1992.
Online Learning Resources: **1. https://nptel.ac.in/courses/112/104/112104033/**

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Course Code	21D33209	Testing of Combustion & Emissions of Internal Combustion Engine Laboratory (21D33209)	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

- Tounderstandthe behaviorofICEnginesatdifferentoperatingconditions

Course Outcomes (CO):

- Onsuccessful completion ofthiscoursethestudentwill beable tohave hands onexperience intestingofengines.

LIST OF EXPERIMENTS

1. Computerized 4 – Stroke Single Cylinder Variable Compression Ratio Engine with Water cooled Eddy current Dynamometer Test rig.
2. Computerized 4 – Stroke Single Cylinder Petrol Engine with Water cooled Eddy current Dynamometer Test rig using Combustion Analyzer with DAQ
3. 4-stroke 4 Cylinder Diesel Engine with water cooled Eddy Current Dynamometer test rig using Combustion Analyzer.
4. Performance test on P-θDiagram on computer controlled single cylinder 4-stroke Diesel Engine.
5. P-V Diagram on computerized controlled single cylinder 4 – stroke Engine.
6. Emission parameters on Anil engine.
7. Measurement of Smoke Density using smoke meter on a 4-Stroke Diesel Engine.
8. Measurement of exhaust emission by 5 gas analyzer.
9. Measurement of octane number for different blends of gasoline.
10. Measurement of Cetane number for different blends of diesel fuel.

Online learning resources/Virtual labs:

1. https://nptel.ac.in/content/syllabus_pdf/112104033.pdf

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Course Code	21D33210	ENGINE DESIGN LABORATORY (21D33206)	L	T	P	C
Semester	II		0	0	4	2

Course Objectives: Thecourseshouldenablethestudentsto

- Know about the design of engine component piston.
- Know about the design of engine component piston pin and piston ring.
- Know about the design of engine component connecting rod and its components.
- Know about the design of connecting rod.
- Know about the design of fly wheel.
- Know about the design of inlet and exhaust valve.
- Know about the design of cam, camshaft and the design of engine cylinder and cylinder block.

Course Outcomes (CO): Onsuccessful completion ofthislaboratorythestudentwill beable tohave hands onexperience in

- Design and draw the piston, piston pin and piston rings as per the engine specification.
- Design and draw the crank shaft components such as shank design, design of big end cap and bolt as per the engine specification.
- Design and draw the crankshaft and the balancing weight as per the engine specification.
- Design and draw the fly wheel as per the engine specification.
- Design and draw the IC engine valve for both inlet and exhaust as per the engine specification.
- Design and draw the cam, cam shaft as per the engine specification.
- • Design the cylinder and cylinder block dimensions as per the engine specification.

LIST OF EXPERIMENTS

1. Modeling and analysis of Piston
2. Modeling and analysis of Piston Pin and Piston Rings
3. Modeling and analysis of Connecting Rod
4. Modeling and analysis of Crankshaft
5. Modeling and analysis of Camshaft
6. Modeling and analysis of Inlet and Exhaust Valves
7. Modeling and analysis of Engine Cylinder
8. Modeling and analysis of flywheel.

Online learning resources/Virtuallabs:

1. https://nptel.ac.in/content/storage2/courses/112104033/

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Course Code		(Program Elective Course –V)	L	T	P	C
Semester	III	a. FUEL CELL TECHNOLOGY	3	0	0	3

Course Objectives: The course should enable the students to:

To present a problem oriented in depth knowledge of fuel cell technology.
• To address the underlying concepts, methods and application of fuel cell technology

Course Outcomes (CO):

- Understand various types of Fuel Cells, its construction & working principles.
- Understand the Fuel Cells for automotive applications.
- Gain knowledge about the different types of fuels used in Fuel Cells
- Doan analysis&comparativestudyoffuelcellswithothertypesofalternate fuels.
- Can find the applications of all the areas in day to day life.

UNIT – I	**FUELCELLSTYPES**	Lecture Hrs:9

INTRODUCTION TO FUEL CELLS Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells – thermodynamics and electrochemical kinetics of fuel cells.

UNIT – II	**FUELCELLSFORAUTOMOTIVEAPPLICATIONS**	Lecture Hrs:9

Fuelcellsforautomotiveapplications-Technologyadvancesinfuelcellvehiclesystems-Onboardhydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system –Alkaline fuel cell-Road map to market.

UNIT - III	**FUELCELLCOMPONENTSANDTHEIRIMPACTON PERFORMANCE**	Lecture Hrs:9

Fuel cell performance characteristics - Current/voltage, Voltage efficiency and power density, ohmic resistance, Kinetic performance, Mass transfer effects - Membrane electrode assembly components, Fuel cell stack, Bi-polar plate, Humidifiers and cooling plates.

UNIT - IV	**FUELING**	Lecture Hrs:9

Hydrogenstoragetechnology-Pressurecylinders,Liquidhydrogen,Metalhydrides,Carbonfibers-Reformer technology - Steam reforming, Partial oxidation, Auto thermal reforming - CO removal,Fuelcelltechnology based on removal like bio-mass.

UNIT - V	**FUELCYCLEANALYSIS**	Lecture Hrs:9

Introduction to fuel cycle analysis - Application to fuel cell and other competing technologies like battery powered vehicles, SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.

Textbooks:

- Ramalingam,K.K, Internal Combustion Engine, Scitech Publication (India) Pvt.Ltd.2000.
- Domkundwar, V.M, A Course in Internal Combustion Engines, DhanpatRai and Co., 1999.
- Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill Book Co., 1995.
- FuelCellsforautomotiveapplications-professionalengineeringpublishingUK.ISBN1-86058 4233,2004.

Reference:

- Eric Chowanietz, Automobile Electronics, SAE International, 1995.
- SAE Inc., Advanced Power Plant Concepts, SP - 1325, 1998.
- MichaePlintand Anthony Martyr, Engine testing Theory and Practice (Second Edition) SAE International, 1999.
- SAE Inc, Advancements in Electric and Hybrid Electric Vehicle Technology, SP - 1023, 1994.

Online Learning Resources:

1. lecture34.pdf (nptel.ac.in)

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Course Code		(Program Elective Course –V)	L	T	P	C
Semester	III	b. SPECIALTY ENGINES	3	0	0	3

Course Objectives:The course should enable the students to:

1. Penetrate deep into engine classification, construction and operation of IC engines with latest technologies
2. Grasp the importance SI and CI engine application in automobiles
3. Understand the performance parameters and testing methodologies.
4. Understand the necessity of Ignition system SI engines
5. Understand the combustion process for both SI and CI engines, the concepts of Governors, Fuel pump, Fuel Injectors.
6. Understand the trends in power plants in military and combat vehicles, the Suspension brakes and safety of heavy vehicles, the vehicle operation and control of farm vehicles and the vehicle automated tracks.

Course Outcomes (CO): Student will be able to

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

- Describe SI and CI engine system application in automobiles.
- Grasp the basic engine terminologies
- Differentiate the fuel dynamics for SI and CI engines and define the key terms such as carburetion, stoichiometric ratio, etc.,
- Design combustion chambers for diesel engines with reference to variable compression ratios
- Analyze the air dynamics within the combustion chamber and determine the performance characteristics for both SI and CI engines theoretically.
- Describe the working of drive line in combat vehicles and earth moving vehicles compared with commercial vehicles and describe the working of power trains in heavy vehicles and able to analyse the ride characteristics of tractors.

UNIT - I	**INTRODUCTION**	Lecture Hrs:9

The design features of Automotive, Locomotive, Marine, Stationary and Generator-set engines.

UNIT - II	**S.I. ENGINE SYSTEMS**	Lecture Hrs:9

Spark ignition engine system variants - Stoichiometric, Lean-burn, port injected/direct injected, Carburetted, Air assisted fuel injection engines, HEV Engines. Illustrations - Honda CVCC, Toyota Prius, Orbital Engine etc. Rotary Piston Engines, Dedicated alternative fueled engine systems - CNG, LPG, H2, Alcohols, Stirling cycle.

UNIT - III	**C.I. ENGINE SYSTEMS**	Lecture Hrs:9

Compression ignition engine system variants - Low, Medium and High-speed system characteristics, High pressure fuel injection systems, Homogeneous Charge Compression Ignition systems, Dual and dedicated alternate fueled engine systems, Coal and producer gas fueled engine systems, Cogeneration system, Total engine systems.

UNIT - IV	**SPECIAL PURPOSE ENGINE SYSTEMS**	Lecture Hrs:9

Engines for special applications -Mining Defence, Off-highway - Tractor, Bulldozer etc. Submarines, Race car engine systems, Flexible fueled systems.

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UNIT - V	**LIFE CYCLE ANALYSES OF ENGINE SYSTEM**	Lecture Hrs:9

Life cycle cost.

Textbooks:

- Ramalingam,K.K, Internal Combustion Engine, Scitech Publication (India) Pvt.Ltd.2000.
- Domkundwar, V.M, A Course in Internal Combustion Engines, DhanpatRai and Co., 1999.
- Mathur,M.L., and Sharma,R.P., A Course in Internal Combustion Engines, DhanpatRai Publications (P) Ltd., 1998.
- Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill Book Co., 1995.
- Some Unusual Engines, L.J.K. Setright, Mechanical Engineering Publication Ltd., UK, 1975.
- The Wankel R C Engine, R.F.Ansdale, A.S.Barnes&Co.,USA, 1969.
- Bosch Technical Instruction Booklets, Robert Bosch GmbH, Germany, 1985.

Reference:

- The Warnkel Engine, Design, Development, Application,JanP.Norbye, Chilton Book Company, USA,1971.
- Introduction to Internal Combustion Engines, Richard Stone, Third Edition, Society of Automotive Engineers, Inc,USA, 1999.
- Diesel Engine Reference Book, Bernard Challen and RodicaBaranescu (Editors) 2ns Edition, R - 183, SAE International , 1999

Online Learning Resources:

1. **https://nptel.ac.in/courses/112/103/112103262/**

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Course Code	21D33303	ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL	L	T	P	C
Semester	III	(PE – V)	3	0	0	3

Course Objectives: The course should enable the students to:

1. To impart knowledge on the atmosphere and its present condition, global warming and eco legislations.
2. To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
3. To elaborate on the technologies available for generating energy from waste..

Course Outcomes (CO): Student will be able to

1. Understand detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation

UNIT - I	INTRODUCTION	Lecture Hrs:9

Global atmospheric change – greenhouse effect – Ozone depletion - natural cycles -mass and energy transfer – material balance – environmental chemistry and biology –impacts – environmental. Legislations. Pollutants - sources and effect – air pollutionmeteorology– atmosphericdispersion–indoorairquality-controlmethodsandequipments-issuesinairpollutioncontrol– air sampling and measurement.

UNIT - II	AIRPOLLUTIONCONTROL	Lecture Hrs:9

Air Pollution Control equipment for particulate matter & gaseous pollutants– gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostatic precipitator (ESP). –Adsorption, Absorption, Scrubbers, Condensation and Combustion.

UNIT - III	WATERPOLLUTION	Lecture Hrs:9

Water resources - water pollutants - characteristics – quality - water treatment systems –waste water treatment- treatment, utilization and disposal of sludge- monitoring compliance with standards.

UNIT - IV	WASTE MANAGEMENT	Lecture Hrs:9

Sources and Classification–Solid waste–Hazardous waste-Characteristics– Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization

UNIT - V	OTHER TYPES OF POLLUTION FROM INDUSTRIES	Lecture Hrs:9

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollutioncontrol–waterpollutionfromtanneriesandotherindustriesandtheircontrol–environmentimpactassessmentforvariousprojects –case studies.

Textbooks:

1. G.Masters (2003):Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, NewDelhi.
2. H.S.Peavy,D.R, .Rowe, G.Tchobanoglous (1985): Environmental Engineering McGraw - Hill Book Company, NewYork.

Reference:

1. H.Ludwig, W.Evans (1991): Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J.
2. ArcadioPSincero and G. A.Sincero, (2002): Environmental Engineering–A Design Apporach, Prentice Hall of India Pvt Ltd, New Delhi

Online Learning Resources:• https://authors.library.caltech.edu

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Course Code		**Open Elective**	**L**	**T**	**P**	**C**
Semester	**III**	**Mechatronics**	**3**	**0**	**0**	**3**

Course Objectives:

1. To impart knowledge on
2. To impart knowledge on about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Course Outcomes (CO): Student will be able to

1. Students can able to understand the concepts,need and importance of mechatronics.
2. They can able to know the concepts of 8085 microprocessor, 8051 microcontroller
3. They can able to understand the Programmable peripheral Interface
4. Students can able to know the structure, programming and selection of PLC
5. They can able to know the working principle and design concepts of actuators, mechatronic system.

UNIT – I	Lecture Hrs:

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.

UNIT – II	Lecture Hrs:

8085 MICROPROCESSOR AND 8051 MICROCONTROLLER
Introduction – Architecture of 8085– Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,.

UNIT – III	Lecture Hrs:

PROGRAMMABLE PERIPHERAL INTERFACE
Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT – IV	Lecture Hrs:

PROGRAMMABLE LOGIC CONTROLLER
Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT – V	Lecture Hrs:

ACTUATORS AND MECHATRONIC SYSTEM DESIGN
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Textbooks:

1.Bolton, “Mechatronics”, Printice Hall, 2008 2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice Hall, 2008.

Reference Books:

1. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", McGraw Hill International edition, 2007.
2. Bradley D.A, Dawson D, Buru N.C and Loader A.J, "Mechatronics", Chapman and Hall, 1993.
3. Smaili.A and Mrad.F , "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press,2007.
4. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company,2007.
5. Krishna Kant, "Microprocessors & Microcontrollers", Prentice Hall of India,2007.
6. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print,2013

Online Learning Resources:

https://nptel.ac.in › courses › noc21 › SEM1 › noc21-me27