SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with "A" Grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119.
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ISO 9001:2015

SCHOOL OF MECHANICAL ENGINEERING

DEPARTMENT OF AUTOMOBILE ENGINEERING

BOARD OF STUDIES MEETING HELD ON 29.10.2018

Members present:

External Members	Signature	Internal Members	Signature
Dr.G.Sathiyaseelan General Manager-Ashok Leyland- External Member		Dr.S.Prakash Dean/School of Mechanical Engineering	
Mr.A.J.Naveenan Lawrence Chief training officer TVS Training and services Ltd Chennai		Dr.V.K.Bupesh Raja, Head/Automobile Engineering	
Er.Dinesh Procurement Consultant Altron Deutschland S.A.S.&Co.KG, U.K (Alumni)		Dr.A.Karthikeyan Professor/ Automobile Engineering	

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Minutes of the Board of Studies meeting

Board of Studies meeting for the Department of Automobile Engineering held on 29th october 2018 with the following agenda:

1. Discussion on New Curriculum Structure for 2019 Regulations
2. Inclusions or exclusions of courses in the revised B.E Automobile Engineering.
3. Inclusions or exclusions of contents of the courses in the revised B.E Automobile Engineering.

Welcome Address

Dr.V.K.Bupesh Raja welcomed the members of BoS and placed the agenda for the deliberations of the members. The following decisions were made as per the items of the circulated agenda.

Agenda1: Discussion on New Curriculum Structure for 2019 Regulations

With reference to the regulation 2015, the following discussions are made for the new curriculum design – Regulations 2019

- No Credit for Environmental Sciences and Engineering course to be provided in the R2019 Curriculum. The total credits for Humanities and Social Sciences category subjects will be increased from six (6) to Nine (9).
- The total credits may be limited to 26 for Basic Science Course Category
- The total credits may be limited to 24 for Engineering Science Course Category
- The total Credits may be limited to 54 for Professional Core course category

- Two more courses (3 credits each) can be included in the Professional Elective Course Category
- Three (3) Credits to be provided for Mathematics 1 to Mathematics 4 courses. Total credits for Mathematics courses are 12.
- Reduce the credits for Project and Professional Training from 25 to 15.
- Project work to be started in the 7th semester, so Project credit of 10 should be split as 3 (for 7th sem) and 7 (for the 8th sem). This will facilitate projects to turn into publications and patents.
- Three Credits (3) for Professional Training and Two Credits (2) for Placement Training (Mandatory for all Students).
- All Lab Courses / Component credits to be increased from 1.5 to 2 Credits.
- The total credits should be in the range of 160 to 165 as per the new guidelines
- No Credit for Induction Programme / Indian Constitution / Essence of Indian tradition
- Comply with AICTE Norms

Agenda 2: Inclusions or exclusions of courses in the revised B.E Automobile Engineering Syllabus

Dr.G.Sathiyaseelan emphasized the need to introduce two separate courses namely Automotive Petrol Engines and Automotive Diesel Engines instead of Automotive Engines course in the syllabus in order to impart in-depth knowledge on engines.

Dr.G.Sathiyaseelan also suggested shifting of Hybrid and Electric Vehicles course from elective to core course category since it is an emerging technology and shall be useful for placement.

As per the inputs received from Alumni, Finite element analysis course is introduced as core course as some foreign universities made it mandatory for admission to master degree.

As prescribed by AICTE the credits in the new curriculum are reduced from 195 to

165. In this context as per the suggestions received from faculty members, the following courses were ratified without any lacuna in contents of curriculum

i. Strength of materials, and Fluid mechanics and machinery course contents are consolidated into a single course titled Solid and Fluid mechanics.

ii. Engineering thermodynamics and Thermal Engineering course contents are consolidated into a single course titled Applied Thermodynamics.

iii. Kinematics of Machines and Dynamics of machines course contents are consolidated into a single course titledMechanics of machines.

As suggested by Mr.A.J.Naveenan Lawrence the laboratory course tilted "Fuels, lubricants and Engine testing lab" is reframed into two individual lab courses namely, Fuels and lubricants lab and Thermal Engineering lab. This shall facilitate in-depth understanding of the core concepts

Agenda3: Inclusions or exclusions of contents of the courses in the B.E-Automobile Engineering Syllabus

Mr.A.J.Naveenan Lawrence emphasized to include Alternate fuels topics in the syllabus of the course titled "Fuels and lubricants"

Dr.G.Sathiyaseelan suggested modifying the syllabus of the course titled "Vehicle dynamics" so as to include the major topics vertical, Lateral and longitudinal dynamics.

Dr.G.Sathiyaseelan also suggested modifying the syllabus of the course titled "Heat and mass transfer" so as to include the topics relevant to engine heat transfer. Further he suggested reframing the title of the course as "Heat transfer applied to I.C engines".(Annexure-1)

Vote of Thanks

Dr.S.Prakash thanked the expert members for accepting the invitation for attending the BOS meeting in a short notice. He thanked them for their valuable suggestions on the agenda items presented. He also thanked Dr.V.K.Bupesh Raja, Professor and HoD, Dr.A.Karthikeyan, Professor for their contribution towards the conduct of this BOS meeting.

- Red colour indicates deleted contents and Yellow colour indicates added contents.

Annexture-1

SAU1201	FUELS AND LUBRICANTS	L	T	P	Credits	Total Marks
		3	0	0	3	100

OBJECTIVES:

- To understand the manufacturing, properties and testing of fuels and lubricants used in automotive applications

UNIT 1: MANUFACTURE OF FUELS AND LUBRICANTS **8 hrs.**

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, distillation curve

UNIT 2: THEORY OF LUBRICATION **7 hrs.**

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

UNIT 3: LUBRICANTS **10 hrs.**

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

UNIT 4: PROPERTIES AND RATING OF FUELS **10 hrs.**

Types of fuels, liquid and gaseous fuels, heating value of fuels, higher and lower heating values, chemical structure of hydro-carbons SI engine fuels, volatility characteristics, desirable characteristics of SI engine fuels, knock rating and additives,

UNIT 5: COMBUSTION & ANALYSIS **10 hrs.**

Stoichiometry - calculation of theoretically correct air required for combustion of liquid and gaseous fuels, volumetric and gravimetric analysis of the dry products of combustion, mass of dry gas per kg of fuel burnt, mass of carbon in the exhaust gas, mass of carbon burnt to carbon-monoxide per kg of fuel, heat loss due to incomplete combustion, exhaust gas analysis by Orsat apparatus.

TOTAL: 45 hrs

On completion of the course, student will be able to

CO1: Recall the structure of petroleum and explain the petroleum refining process and manufacture of lubricants in detail.

CO2: Explain the properties of fuels and their effect on engine performance

CO3: Explain the qualities of fuels and various additives used to enhance performance of fuels and

CO4: Explain the theory of lubrication and effect of engine variables on friction

CO5: Explain the requirements and various properties of lubricants and compare different types of Lubricants.

CO6: Derive theoretically correct air required for combustion of liquid and Gaseous fuels

REFERENCE BOOKS:

1. Ganesan. V. “Internal Combustion Engines”, Tata McGraw-Hill Publishing Co., New Delhi, 2003.
2. Mathur D.S., Sharma. R.P. “A course in internal combustion engines”, Dhanpatrai publication, 2003.
3. Obert. E.F. “Internal Combustion Engineering and Air Pollution”, International book Co., 1988.
4. Brame. J.S.S. and King. J.G,”Fuels – Solids, Liquids, Gaseous”,Edward Arnold, London, 1955.
5. Francis. W “Fuels and Fuel Technology”, Published by Pergamon Press Inc, 1980.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration : 3 Hrs.**

PART A : 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 16 marks **80 Marks**

SAUA1303	FUELS AND LUBRICANTS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the refining process of petroleum.
- To develop understanding about various types of fuels, lubricants and their properties
- To understand the importance of Alternate fuels available.

UNIT 1 MANUFACTURE OF FUELS AND LUBRICANTS **9 Hrs.**

Fuels, Classification, Structure of petroleum, refining process, thermal and catalytic cracking, products of refining process, manufacture of lubricating oil base stocks and finished automotive lubricants.

UNIT 2 FUELS FOR I.C. ENGINES **9 Hrs.**

Types of Fuels, Liquid and gaseous fuels, heating value of fuels, higher and lower heating values, chemical structure of hydro-carbons SI Engine fuels, Volatility characteristics, desirable characteristics of SI Engine fuels, knock rating and additives, CI engine fuels, desirable characteristics, cetane rating and additives

UNIT 3 COMBUSTION OF FUELS **9 Hrs.**

Stoichiometry - calculation of theoretically correct air required for combustion of liquid and Gaseous fuels, volumetric andgravimetric analysis of the dry products of combustion, mass of dry gas per kg of fuel burnt, mass of carbon in the exhaust gas, mass of carbon burnt to carbon monoxide per kg of fuel, heat loss due to incomplete combustion, exhaust gas analysis by Orsat apparatus.

UNIT 4 LUBRICANTS **9 Hrs.**

Theory of Lubrication, Effect of engine variables on friction, Types of Lubrications- Hydrodynamic and Hydrostatic lubrication. Requirements for automotive lubricants and types, Viscosity index, oxidation deterioration and degradation oflubricants, additives of lubricants and synthetic lubricants, classification of lubricating oils, tests on lubricants. Grease, classification, properties, testing of grease.

UNIT 5 ALTERNATE FUELS **9 Hrs.**

Alternate fuels for SI engines and CI engines, desirable characteristics, Octane and cetane rating. Introduction to electric, hybrid and fuel cell vehicles

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the structure of petroleum and explain the petroleum refining process and manufacture of lubricants indetail.
CO2 - Explain the properties of fuels and their effect on engine performance
CO3 - Explain the qualities of fuels and various additives used to enhance performance of fuels and Derive theoretically correct air required for combustion of liquid and Gaseous fuels
CO4 - Explain the theory of lubrication and effect of engine variables on friction
CO5 - Explain the requirements and various properties of lubricants and compare different types of Lubricants
CO6 - Summarize the alternate fuels for SI and CI engines and alternate source vehicles

TEXT / REFERENCE BOOKS

1. Ganesan V., "Internal Combustion Engines", Tata McGraw Hill Publishing Co., New Delhi, 2012.
2. Mathur D.S., Sharma. R.P. "A course in internal combustion engines", Dhanpatrai publication, 2014.
3. Srivastava S.P., Jenõ Hancsók "Fuels and Fuel-Additives" Wiley; 1st Edition, 2014.
4. Srivastava S.P., "Developments in Lubricant Technology", Wiley Blackwell, 1 Edition, 2014.
5. Gupta O.P., "Elements of Fuel & Combustion Technology", Khanna Book Publishing; 1st Edition, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 10 Questions of 2 marks each - No choice **20 Marks**
PART B: 2 Questions from each unit of internal choice; each carrying 16 marks **80 Marks**

SAU1304	VEHICLE DYNAMICS	L	T	P	Credits	Total Marks
		3	1	0	4	100

OBJECTIVE

- To understand basic principles of vibration and dynamic analysis of vehicles

UNIT 1: INTRODUCTION **12 hrs**

Classification of vibrations- mechanical vibrating systems, single degree of freedom, two degree of freedom, multi degree of freedom, free, forced and damped vibrations, modeling and simulation studies, model of an automobile, magnification factor, transmissibility, vibration absorber.

UNIT 2: APPLIED NUMERICAL METHODS **12 hrs**

Close-coupled and far-coupled systems, determination of mass & stiffness matrices -eigen value problems- -orthogonality of mode shapes, modal analysis, approximate methods for determining fundamental frequency, Dunkley's lower bound, Rayleigh upper bound, Holzer method for closed coupled system and branched system.

UNIT 3: SUSPENSION SYSTEM **12 hrs**

Vehicle dynamics and suspension requirements, natural spring frequencies, force acting on a semi-elliptic suspension, design of laminated spring, design of coil spring and torsion bar, spring characteristics, mechanics of an independent suspension system, roll axis and the vehicle under the action of side forces, coupled front and rear suspension effects, relative pitch and bounce frequencies, anti-roll rates, roll angles in cornering, attitudes changes due to brakes, traction and independent suspension.

UNIT 4: PERFORMANCE OF AUTOMOBILES **12 hrs**

Forces and couples on the wheels, tractive and braking properties of tires, cornering properties of tires, slip angle, cornering force, camber thrust, deformation of wheel and ground, power of propulsion, road performance curves, resistances- air, rolling and grade, determination of center of gravity of vehicle, load distribution, stability on a curved track slope and a banked road, calculation of tractive effort and reactions for different drives.

UNIT 5: WHEELS AND TYRES **12 hrs**

Automobile wheels, pneumatic tires, tire- construction, properties, characteristics, tread, bite, operation and inflation pressure, wheel balancing, tire, dynamics, ride characteristics power consumed by a tire, over steer, under steer, steady state cornering, effect of braking, driving torques on steering, effect of camber, transient effects in cornering

TOTAL: 60 hrs

REFERENCE BOOKS:

1. Giri N.K – Automotive Mechanics, Khanna Publishers, 2002.
2. Rao J.S and Gupta. K "Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd., New Delhi - 2002.
3. Ellis.J.R - "Vehicle Dynamics"- Business Books Ltd., London- 1991
4. Giles.J.G.Steering - "Suspension and Tyres",- Illiffe Books Ltd., London- 1998
5. Wong J.Y. Theory of Ground Vehicles, 4th edition, Wiley
6. Thomas D. Gilespie, "Fundamental of Vehicle Dynamics, Society of Automotive Enginers", USA 1992.
7. Rajesh Rajamani, "Vehicle Dynamics and Control", Springer, 2012.

Course Outcomes:

On completion of the course, students will be able to

CO1: Understand vibration modes and its problems related to Automobile Engineering.
CO2: Understand how passenger comforts is achieved along with vehicle stability.
CO3: Design and conduct experiments on tires on different road conditions.
CO4: Demonstrate the ability to design a system, component or process to meet the stability needs of vehicles
CO5: Understand the concepts in lateral and longitudinal dynamics of automobiles.
CO6: Understand the methods of predicting vehicle performance.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration : 3 Hrs.**

PART A : 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 16 marks **80 Marks**

SAU1304	VEHICLE DYNAMICS	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

- To familiarize with dynamic analysis of vehicles.
- To demonstrate the ability to design a system, component or process to meet the desired needs within realistic constraints.
- To acquire the capability to identify, formulate and solve complex engineering problems related to Automobile Engineering.

UNIT 1 CONCEPT OF VIBRATION **9 Hrs.**

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT 2 VERTICAL DYNAMICS **9 Hrs.**

Human response to vibration, Sources of Vibration. Design and analysis of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and their properties.

UNIT 3 TIRES **9 Hrs.**

Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire-road friction. Test on Various road surfaces. Tire vibration.

UNIT 4 LATERAL DYNAMICS **9 Hrs.**

Steady-state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Roll center, Roll axis, Vehicle underside forces. Stability of vehicle on banked road, during turn. Effect of suspension on cornering.

UNIT 5 LONGITUDINAL DYNAMICS AND CONTROL **9 Hrs.**

Aerodynamic forces and moments. Equation of motion. Tire forces, rolling resistance, Load distribution for three wheeler and four wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand vibration modes and its problems related to Automobile Engineering.
CO2 - Able to understand how passenger comfort is achieved along with vehicle stability.
CO3 - Ability to design and conduct experiments on tires on different road conditions.
CO4 - Demonstrate the ability to design a system, component or process to meet the stability needs of vehicles
CO5 - Understand the concepts in lateral and longitudinal dynamics of automobiles.
CO6 - Understand the methods of predicting vehicle performance.

TEXTBOOKS/ REFERENCES

1. Singiresu S. Rao, "Mechanical Vibrations", 6th Edition, Prentice Hall, 2017.
2. Dieter Schramm, " Vehicle Dynamics- Modeling and Simulation", Springer, 2016.
3. Wong. J. Y., "Theory of Ground Vehicles", 5th Edition, Wiley-Interscience, 2013.
4. Hans B Pacejka, "Tire and Vehicle Dynamics", 3rd Edition, SAE International, 2012.
5. John C. Dixon," Tires, Suspension, and Handling", 4th Edition, Society of Automotive Engineers Inc, 2013.
6. Jan Zuijdijk, 'Vehicle dynamics and damping", Author House, 2013.
7. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", 2nd Edition, Elsevier Limited, 2014
8. NakhaieJazar. G., "Vehicle Dynamics: Theory and Application", 2nd edition, Springer, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration : 3 Hrs.**

PART A : 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 16 marks **80 Marks**

SME1309	HEAT AND MASS TRANSFER (Common to Mech & Auto)	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1: Analyse the conduction heat transfer characteristics for both simple and composite geometries.
CO2: Evaluate the physical problems related to free and forced convection situation.
CO3: Design and analyze the heat exchangers with LMTD and NTU procedures.
CO4: Apply the laws of radiation to the different surfaces and Evaluate the radiation properties and shape factor.
CO5: Analyze the similarity in governing equations of mass transfer.
CO6: Evaluate the convective mass transfer correlations.

UNIT 1 CONDUCTION **12 Hrs**

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier Law of Conduction – Cartesian - Cylindrical – Polar Coordinates– One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems-critical thickness of insulation – Conduction with Internal Heat Generation – Systems with Variable Thermal Conductivity - Extended Surfaces- Fins--Classification – Unsteady Heat Conduction – Lumped Analysis – Infinite and Semi Infinite Solids – Heislerand Grober Charts. Finite difference method for multi dimensional heat conduction

UNIT 2 CONVECTION **12 Hrs**

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Forced Convection –External Flow– Flow over Plates, Cylinders Spheres and Bank of tubes – Internal Flow – Laminar and Turbulent Flow Solutions – Analogies between momentum and heat transfer- Reynolds anology-Chilton colburn anology (Modified Reynolds anology)- Free Convection – Flow over Vertical Plate – Vertical Tubes - Horizontal Plate, Inclined Plate, Cylinders and Spheres.

UNIT 3 PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS **12 Hrs.**

Film and Drop wise Condensation - Nusselt's theory of condensation- Regimes of pool boiling and flow boiling, Nucleate Boiling - correlations in boiling and condensation. Heat Exchanger Types – Overall Heat Transfer Coefficient – Fouling Factors – Analysis – LMTD method, – NTU method. - Introduction of TEMA Standards.

UNIT 4 RADIATION **12 Hrs**

Basic Concepts, Laws of Radiation- Wiens Displacement Law – Hemispherical Emissive Power - Stefan Boltzman Law, Kirchoff Law – Black Body Radiation – Grey body radiation – Shape Factor – Electrical Analogy – Radiation Shields-Solar radiation.

UNIT 5 Mass Transfer

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective MassTransfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

Max.60 Hrs.

TEXT/ REFERENCE BOOKS

1. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata Mc Graw Hill, 2004
2. Rajput R.K.," Heat and Mass transfer", S.Chand & Co, 1983.
3. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998.
4. Kothandaraman C.P., "Fundamentals of Heat and Mass Transfer", New Age International (P) Ltd., 1998
5. Sachdeva R.C., "Fundamentals of Heat and Mass Transfer", New Age Internationals (P) Ltd., 2010
6. Ozisik N.M., "Heat Transfer", McGraw Hill Book Company, 1988.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A:	2 Questions each from CO1-CO4, 1 question each from CO5 and CO6 – No choice	**20 Marks**
PART B:	4 Questions each with internal choice from CO1-CO4, 1 question from CO5 and CO6 with internal choice, each carrying 16 marks	**80 Marks**

SAUA1503	HEAT TRANSFER APPLIED TO I.C ENGINES	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- Impart the knowledge of fundamentals of heat transfer
- Deep understanding on the governing equations for convection heat transfer and the dimensionless parameters
- Understand the temperature distribution and heat transfer rate in engine components
- Familiarize with cooling system and measurement of heat transfer rate in IC engines

UNIT1 CONDUCTION **9 Hrs.**

Fourier law of conduction, general equation in Cartesian, cylindrical, spherical co-ordinates – 1 Dimensional steady state conduction in solids across plane wall - composite wall - composite cylinder - composite sphere with convection boundaries, overall heat transfer co-efficient, critical thickness of insulation, conduction with generation, thermal contact resistance, variable conductivity.

UNIT 2 CONVECTION **9 Hrs.**

Forced convection - external flow over a plate; cylinder, sphere & non circular ducts- internal flow through pipes- annularspaces & non circular conducts. Natural convection from vertical inclined &horizontal surfaces.

UNIT 3 RADIATION **9 Hrs.**

Electromagnetic spectrum, black body emission, emissive power, laws of radiation, radiationshape factor, electrical analogy, radiation shields gas radiation.

UNIT 4 HEAT TRANSFER AND COOLING IN IC ENGINES **9 Hrs.**

Temperature distribution in cylinder, piston – engine heat transfer and energy balance – parameters- Extended Surfaces- Fins-Heat Exchanger Types - Overall Heat Transfer Coefficient - Fouling Factors - Analysis - LMTD method, - NTU method - Classification -cooling system-need for cooling system-power required to cool the engine-characteristics of efficient cooling system-types of cooling system.

UNIT 5 MEASUREMENT OF HEAT TRANSFER RATES IN IC ENGINES **9 Hrs.**

Measurement methods-SI engine measurement-CI engine measurement –evaluation of heat transfer correlations-boundary layer behavior-components temperature distribution - effect of engine variables-temperature measurement.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic modes of heat transfer
CO2 - Compute temperature distribution in steady-state heat conduction.
CO3 - Understand principles of forced and free convection heat transfer processes.
CO4 - Understand the principles of radiation heat transfer.
CO5 - Understand the cooling systems in IC engines.
CO6 - Estimate the temperature distribution and heat transfer rate in IC engine.

TEXT / REFERENCE BOOK

1. Heywood J.B "Internal Combustion Engine Fundamentals", McGraw-Hill Book CO., USA - 1995.
2. Rajput.R.K, Heat and Mass transfer – S.Chand& Co, 2016.
3. Kothandaraman C.P. Fundamentals of Heat and Mass Transfer - New Age International (P) Ltd., 1998.
4. Sachdeva R.C. Fundamentals of Heat and Mass Transfer - New Age Internationals (P) Ltd.
5. Ozisik N.M., Heat Transfer - McGraw Hill Book Company, 1988.
6. Holman J.P. Heat Transfer – McGraw Hill Book Company, 1989.
7. Incropa and Dewite, Heat Transfer - John Wiley.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 10 Questions of 2 marks each – No choice **20 Marks**
PART B: 2 Questions from each unit of internal choice; each carrying16 marks **80 Marks**