DEPARTMENT OF MECHANICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – PART I			
Name of the programme and specialization	B.Tech / Mechanical Engineering		
Course Title	ADVANCED IC ENGINES		
Course Code	MEPE12	**No. of Credits**	3
Course Code of Pre-requisite subject(s)	MEPC17 – Thermal Engineering		
Session	July 2022	**Section (if, applicable)**	A & B
Name of Faculty	Dr. S Vedharaj	**Department**	Mechanical Engineering
Email	vedha@nitt.edu	**Telephone No.**	0431-2503413
Name of Course Coordinator(s) (if, applicable)			
E-mail		**Telephone No.**	
Course Type	☐ **Core course** ☑ **Elective course**		

Syllabus (approved in BoS)

SI and CI engines: Mixture requirements – Stages of combustion – Normal and Abnormal combustion, Knock and Pre-ignition – Factors influencing knock – SI Fuel injection systems: Multi Point Fuel Injection (MPFI) & Gasoline Direct Injection (GDI) Systems – Diesel Fuel Injection system: Common Rail Direct Injection (CRDI) & Unit Pump Systems – Fuel Spray behavior – Spray structure and spray penetration – Air motion: Tumble, Swirl & Squish – Different Combustion chamber geometries – Turbo charging – Waste Gate, Variable Geometry turbochargers.

Emission Formation and Control: Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Exhaust Gas Analysis – Methods of controlling emissions – In-cylinder treatments: Injection strategies, Exhaust gas recirculation, Spark Advancement – After treatment systems: Three Way Catalytic converter, SCR, LNT, DOC, DPF and Particulate Traps.

Engine Testing and Measurement Systems: Transient dynamometer, Test cells, chassis dynamometer, Fuel and air flow measurement and conditioning system, in-cylinder pressure transducers and crank angle encoders. Driving cycles for emission measurement, National and International emission Norms, Methods and principles of emission measurement – Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke meters and soot analyzer.

Advanced Combustion concepts: Low Temperature Combustion - Homogeneous charge compression ignition (HCCI) – Reactivity Controlled Compression Ignition (RCCI) – Gasoline Compression Ignition – Spark Assisted HCCI – Six stroke and Eight stroke engines – Pre-chamber SI engine – Dynamic skip firing – Engine Downsizing and Downspeeding.

Combustion Visualization: Optical Engine, Endoscopic access & optical chambers – In-cylinder flow measurements: Particle image velocimetry, Laser Doppler Anemometry – In-cylinder fuel and species measurement:, Planar Laser induced Fluorescence, Raman and Rayleigh Scattering Techniques – Fuel injection and Spray characteristics - Phase Doppler particle analyzer, Mie scattering, Laser sheet droplet sizing – Schlieren and shadowgraphy techniques & Chemi-luminescence Imaging.

REFERENCE BOOKS:

1. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.
2. Fundamentals of internal combustion engines: Gill, Smith and Ziurys, Oxford and IBH.
3. The Internal combustion Engine in theory and practice: C F Taylor, MIT Press, Cambridge.
4. Internal Combustion Engines and Air Pollution: E F Obert, Intext Educational Publishers, NY.
5. Alternative Fuels Guidebook, Properties, Storage, Dispensing, and Vehicle Facility Modifications, Richard L. Bechtold, SAE Publications 1997.
6. Emission from Combustion engines and their control, Patterson D J and Henein N A: Ann Arbor science publishers.
7. Advanced Engine Technology: Heinz Heisler ISBN 0340568224, SAE Publications.
8. Engines: An Introduction, John L Lumley.
9. Hua Zhao, Laser Diagnostics and Optical Measurement Techniques in Internal Combustion Engine, SAE Publications

COURSE OBJECTIVES

- Apply principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of engines and engine components.
- Become aware of the relevance of environmental and social issues on the design process of internal combustion engines.
- Develop mathematical methods for designing components and systems
- Apply numerical methods to perform design calculations.
- Advance proficiency in professional communications and interactions.

COURSE OUTCOMES (CO)

Course Outcomes	**Aligned Programme Outcomes (PO)**
At the end of the course student will be able to	
1. Understand the combustion phenomena in SI engines	1,2,3,5,7,8,11,12
2. Explain the advanced combustion concepts used to increase engine efficiency and reduce emission levels.	1,2,3,5,7,8,11,12
3. Understand the different mechanism of different subsystem used in an engine test bed facility	1,2,3,5,7,8,11,12
4. Explain the advanced imaging techniques used to study the combustion and spray characteristics of the fuel.	1,2,3,5,7,8,11,12
5. Identify the exhaust pollutants formation and measurement techniques	1,2,3,5,7,8,11,12

COURSE PLAN – PART II

COURSE OVERVIEW

This course provides an overview about the combustion and emission formation processes of conventional SI and CI engines, methods adopted to control the emission levels, equipments and measurement devices used for engine testing, advanced high efficiency combustion concepts and different visualization methods adopted for flame, spary and species characterization.

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1.	1st Week	Mixture requirements – Stages of combustion – Normal and Abnormal combustion, Knock and Pre-ignition – Factors influencing knock	Chalk & Talk
2.	2nd Week	SI Fuel injection systems: Multi Point Fuel Injection (MPFI) & Gasoline Direct Injection (GDI) Systems – Diesel Fuel Injection system: Common Rail Direct Injection (CRDI) & Unit Pump Systems	PPT Presentations
3.	3rd Week	Fuel Spray behavior – Spray structure and spray penetration – Air motion: Tumble, Swirl & Squish – Different Combustion chamber geometries – Turbo charging – Waste Gate, Variable Geometry turbochargers.	Chalk & Talk
4.	4th Week	Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Exhaust Gas Analysis	Chalk & Talk
5.	5th Week	Methods of controlling emissions – In-cylinder treatments: Injection strategies, Exhaust gas recirculation, Spark Advancement	Chalk & Talk
6.	6th Week	After treatment systems: Three Way Catalytic converter, SCR, LNT, DOC, DPF and Particulate Traps.	PPT Presentations
7.	7th Week	Transient dynamometer, Test cells, chassis dynamometer, Fuel and air flow measurement and conditioning system, in-cylinder pressure transducers and crank angle encoders.	PPT Presentations
8.	8th Week	Driving cycles for emission measurement, National and International emission Norms, Methods and principles of emission measurement	PPT Presentations
9.	9th Week	Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke meters and soot analyzer.	PPT Presentations

10.	10th Week	Low Temperature Combustion - Homogeneous charge compression ignition (HCCI) – Reactivity Controlled Compression Ignition (RCCI)	Chalk & Talk
11.	11th Week	Gasoline Compression Ignition – Spark Assisted HCCI – Six stroke and Eight stroke engines – Pre-chamber SI engine – Dynamic skip firing – Engine Downsizing and Downspeeding.	Chalk & Talk
12.	12th Week	Optical Engine, Endoscopic access & optical chambers – In-cylinder flow measurements: Particle image velocimetry, Laser Doppler Anemometry	PPT Presentations
13.	13th Week	In-cylinder fuel and species measurement:, Planar Laser induced Fluorescence, Raman and Rayleigh Scattering Techniques	PPT Presentations
14.	14th Week	Fuel injection and Spray characteristics - Phase Doppler particle analyzer, Mie scattering, Laser sheet droplet sizing – Schlieren and shadowgraphy techniques & Chemi-luminescence Imaging	PPT Presentations

COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1.	Cycle test 1	6th Week	90 minutes	20%
2.	Cycle test 2	14th Week	90 minutes	20%
3.	Quiz (Multiple Choice Questions)	12th Week	30 minutes	10%
4.	Assignments	Continuous assessment		10%
5.	End Semester	As per Institute schedule	180 minutes	40%

COURSE EXIT SURVEY

- Student's feedback in the class after every 4 weeks and through class committee meetings.
- Feedback from students on the course outcomes shall be obtained at the end of the course.

COURSE POLICY

MODE OF CORRESPONDENCE (email/ phone etc)

- All the communication (schedule of assessment/ course material/any other information regarding this course) will be intimated through the class representative.
- The Faculty is available for consultation after contact hours with prior appointment through email: vedha@nitt.edu

COMPENSATION ASSESSMENT POLICY

- Attending all the assessments (1, 2, 3, 4, 5) are mandatory for every student. Flexibility is given to the students to fix the date for each mode of evaluation convenient to majority of the students.
- If any student fails to attend the cycle test 1 and 2 due to genuine reason like medical emergency, the student may be permitted to appear for the compensation assessment (CPA) on submission of appropriate documents as proof. (Not valid for students having attendance lag).
- Students not having 75 % minimum attendance at the end of the semester and also didn't attend cycle test 1 and 2 will be awarded 'V' Grade and have to REDO the course.
- In any case, compensation assessment (CPA) is not considered as an improvement test.
- The minimum marks for passing this course and grading pattern will adhere to the regulations of the institute.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- All the students are expected to attend all the contact hours. Students should maintain 75% minimum physical attendance by the end of the course to attend the end semester examination.
- Absence due to medical reason and institutional activities will be considered when the student falls below 75% of physical attendance and it should be supported by a letter (in professional letterhead) from the concerned authorities. Any preparatory works in view of institution activities should not be taken up in class contact hours.
- Students not having 75% minimum attendance at the end of the semester will be awarded 'V' Grade and have to REDO the course.

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.

The above policy against academic dishonesty shall be applicable for all the programmes.

FOR APPROVAL

26-08-2022		06/09/2022
Dr. S. Vedharaj (AP/ME)		
Course Faculty	**CC-Chairperson**	**HOD (ME)**

Guidelines:

a) The number of assessments for a course shall range from 4 to 6.

b) Every course shall have a final assessment on the entire syllabus with at least 30% weightage.

c) **One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered. Details of compensation assessment to be specified by faculty.**

d) The passing minimum shall be as per the regulations.

e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.

f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.