23-24

MECHANICAL ENGINEERING

Prepared By :

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Session 2023-24

Course File

7ME5-11: I. C. Engines

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RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Scheme & Syllabus

IV Year- VII & VIII Semester: B. Tech. (Mechanical Engineering)

7ME5-11: I. C. Engines

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**History of IC engines:** Nomenclature, Classification & Comparison, SI & CI, 4stroke- 2 stroke, First Law analysis, Energy Balance. Fuel-air cycles, Actual cycles.	4
3	**Testing & Performance:** Performance parameters, Measurement of operating parameters e.g. speed, fuel & air consumption, Powers, IHP, BHP, FHP, Efficiencies Thermal, Mechanical, Volumetric, Emission Measurement, Indian & International standards of Testing, Emission.	4
4	**Fuel & Combustion:** Combustion in CI & SI engines, Ignition Limits, Stages of combustion, Combustion parameters. Delay period and Ignition Lag, Turbulence and Swirl, Effects of engine variables on combustion parameters, abnormal combustion in CI & SI engines, Detonation & knocking, Theories of detonation, Control of abnormal combustion, Combustion chamber design principles, Types of combustion chamber.	4
5	**Alternative Fuels:** Methanol, Ethanol, Comparison with gasoline, Manufacturing, Engine performance with pure Methanol, Ethanol & blends, Alcohols with diesel engine, Vegetable oils, Bio gas.	2
6	**Engine Systems & Components:** Fuel System (SI Engine), Carburetion & Injection, process & parameters, properties of A/F mixture, Requirements of A/F ratios as per different operating conditions, Carburettors, types, Aircraft carburettor, comparison of carburetion & injection, F/A ratio calculations.	4
7	**CI engine:** Mixture requirements & constraints, Method of injection, Injection systems, CRDI etc. system components, pumps injectors.	3
8	**Ignition system:** Conventional & Modern ignition systems Magneto v/s Battery, CB point v/s Electronic ignition, Fuel Ignition Energy requirements. Spark advance, centrifugal, vacuum Firing order, spark plugs.	3
9	**Engine Friction & Lubrication:** Determination of friction, Lubrication principles, Types of lubrication, Places of lubrication Bearings and piston rings etc., Functions of Lubrication, Properties, Rating and Classification of lubricating oil, Additives, Lubrication systems. Engine Cooling: Requirements of cooling, Areas of heat flow, High temperature regions of combustion chamber. Heat Balance, Cooling Systems, Air, Water Cooling, Cooling system components.	5

Course Overview:

This course studies the fundamentals of how the design and operation of internal combustion engines affect their performance, efficiency, fuel requirements, and environmental impact. Topics include fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, with reference to engine power, efficiency, and emissions. Students examine the design features and operating characteristics of different types of internal combustion engines: spark- ignition, diesel, stratified-charge, and mixed-cycle engines. The class includes lab project in the Engine Laboratory.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Synthesis	Explain working and performance of IC Engines through thermodynamic cycles.
2	Synthesis	Explain the combustion phenomena in SI and CI engines and factors influencing combustion chamber design.
3	Synthesis	To summarize formation mechanism of IC engines, its effects and the legislation standards.
4	Synthesis	Explain working principles of instrumentation used for engine performance and emission parameters.
5	Synthesis	Develop methods for improving the IC engine performance.

Prerequisites:

1. Basic knowledge of Fluid Mechanics
2. Concepts of Engineering Thermodynamics and Heat Transfer.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific (PSO)					Domain Independent (PO)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	-	-	-	-	1	-	-	-
CO2	3	2	3	2	2	-	-	-	-	-	-	1
CO3	2	2	2	2	2	-	-	-	-	1	-	1
CO4	2	1	-	2	2	1	-	-	1	1	-	1
CO5	1	1	1	2	1	1	-	-	1	1	-	1
1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)												

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**1**	**INTRODUCTION**
2	**2**	**HISTORY OF IC ENGINES:** Students will able to know the nomenclature and Classification of IC engines.
3	2	Students will able to do comparison of SI & CI, 4stroke- 2 stroke engines
4	2	Students will be able to apply first law analysis and energy balance equations.
5	2	Students will be able to analyze analytically Fuel-air cycles, Actual cycles.
6	**3**	**TESTING & PERFORMANCE:** Students will able to identify performance parameters, Measurement of operating parameters e.g. speed, fuel & air consumption
7	3	Students will able to calculate powers, IHP, BHP, FHP
8	3	Students will able to calculate efficiencies like Thermal, Mechanical, Volumetric, Emission Measurement of given parameters of IC engines.
9	3	Students will able to recognise Indian & International standards of Testing ,Emission
10	**4**	**FUEL & COMBUSTION:** Students will able to do combustion in CI & SI engines, Ignition Limits, Stages of combustion
11	4	Students will able to explain combustion parameters. Delay period and Ignition Lag, Turbulence and Swirl, Effects of engine variables on combustion parameters
12	4	Students will able to understand abnormal combustion in CI & SI engines, Detonation & knocking, Theories of detonation, Control of abnormal combustion
13	4	Students will able to understand the combustion chamber design principles, Types of combustion chamber
14	**5**	**ALTERNATIVE FUELS:** Students will able to know about Methanol, Ethanol, Comparison with gasoline, Manufacturing

15	5	Students will able to compare engine performance with pure Methanol, Ethanol n blends, Alcohols with diesel engine, Vegetable oils, Bio gas
16	**6**	**ENGINE SYSTEMS & COMPONENTS:** Students will able to recognise the Fuel System (SI Engine), Carburetion & Injection
17	6	Students will able to understand process & parameters, properties of A/F mixture, Requirements of A/F ratios as per different operating conditions
18	6	Students will able to know the working principle of carburettors, types, Aircraft carburettor
19	6	Students will able to do comparison of carburetion & injection, F/A ratio calculations
20	**7**	**CI ENGINE:** Students will able to identify the mixture requirements & constraints
21	7	Students will able to justify the method of injection, Injection systems, CRDI etc.
22	7	Students will able to know the system components, pumps injectors
23	**8**	**IGNITION SYSTEM:** Students will able to compare between Conventional & Modern ignition systems Magneto v/s Battery
24	8	Students will able to compare between CB point v/s electronic ignition, Fuel Ignition Energy requirements
25	8	Students will able to know about spark advance, centrifugal, vacuum Firing order, spark plugs
26	**9**	**ENGINE FRICTION & LUBRICATION:** Students will able to determine friction, Lubrication principles
27	9	Students will able to classify lubrication, Places of lubrication Bearings and piston rings etc., Functions of Lubrication
28	9	Students will able to know about properties, Rating and Classification of lubricating oil, Additives, Lubrication systems
29	9	Students will able to understand about engine cooling: Requirements of cooling, Areas of heat flow, High temperature regions of combustion chamber
30	9	Students will able to calculate heat balance exercise, Cooling Systems, Air, Water Cooling, Cooling system components
31	**10**	**SUPERCHARGING:** Students will able to know about objectives, Thermodynamic cycle & performance of super charged SI & CI engines
32	10	Students will able to know about the methods of super charging, Limitations
33	10	Students will able to do comparison of 4s & 2s engines construction & valve lining scavenging
34	10	Students will able to identify the process parameters, systems
35	10	Students will able to know the process of Supercharging for 2 stroke engines.
36	**11**	**DUAL & MULTI FUEL ENGINES:** Students will able to Principle of dual and multi fuel engines.
37	11	Students will able to know about dual fuels, Combustion process
38	11	Students will able to know the performance Advantages, Modification in fuel system

39	**12**	**SPECIAL ENGINES:** Students will able to know about working principles of Rotary, Stratified charge
40	12	Students will able to know about the free piston, Variable compression ratio engines

Text Books

1. Mathur & Sharma, Internal Combustion Engines, Dhanpat Rai & Sons
2. John B. Heyword, Internal Combustion Engines Fundamentals, Mcgraw Hill

References

1. "Internal Combustion Engines" by Ganesan V, Mcgraw Hill
2. "Recent Innovations in Internal Combustion Engines" by Nicole Maden, Mcgraw Hill

Assessment Methodology:

1. Conducting vica voce examination on weekly basis.
2. Practical exam in lab where students have to apply their theoretical understanding to perform experiments practically. (Once in a week)
3. Assignments one from each unit.
4. Midterm subjective paper where they have to solve basic questions with numerical and derivations from each unit. (Twice during the semester)
5. Final paper at the end of the semester subjective.

Teaching and Learning resources unit-wise:

Unit-1

History of IC Engine

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Unit-2

Testing & Performance of IC Engine

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Unit-3

Fuel & Combustion

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Alternative Fuels

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Unit-4

Engine System and Components

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

CI Engine

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Ignition System and Components

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Unit-5

Engine Friction and Lubrication

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Supercharging

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Unit-6

Dual & Multiple fuel engine

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Special Engines

Video Tutorials: https://youtu.be/sRu-majrRmM?list=PLwdnzlV3ogoXHbVNKWL1BYOo_8PpyNtnC

Theory concepts: https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/assignments/

Sample Quiz: https://www.sanfoundry.com/1000-ic-engine-questions-answers/

Previous Year Question Papers:

6E3050

6E3050

B.Tech. VI Semester (Back) Examination, April/May - 2017

Mechanical Engineering

6ME2I.C. Engines & Diesel Power Plant

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 26

Instructions to Candidates:

*Attempt any **five questions**, selecting **one question** from **each unit**. All questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitable be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.*

Unit - I

1. a) Explain the various methods of finding the frictional power of an IC engine and discuss the relative merits. **(8)**

b) The air flow to a four cylinder four stroke petrol engine is measured by mean of 7.5 cm diameter sharp edged orifice, cd = 0.6, during a test on the engine the following data were recorded : **(8)**

Bore = 11 cm, stroke = 13 cm

Engine speed = 2250 rev/min

Brake power = 36 kw

Fuel consumption = 10.5 kg/hr

CV of fuel = 42,000 kJ/kg

Pressure drop across the orifice = 4.1 cm of water atmospheric temp & pressure = 15^0 C & 1.013 bar

Calculate : 1) Brake Thermal efficiency

2) Brake mean effective pressure.

3) Volumetric efficiency based on free air conditions.

OR

1. a) Explain the effect of Air fuel ratio on Co, HC No_x emission from petrol engine. **(8)**

   b) Explain the automative pollution control system. **(8)**

Unit - II

2. a) Describe the phenomenon of detonation & discuss different factors affecting detonation in SI engine. **(10)**

   b) Explain the need of additives in the fuels. What are the effects of various additives in engine fuels? **(6)**

OR

2. a) What are the basic requirement of good SI Engine combustion chamber? What are the advantages of overhead combustion chamber over side valve combustion chamber. **(8)**

   b) "Factors which increase detonation in SI Engines, tend to reduce knocking in CI engines". Discuss the validity of the statement. **(8)**

Unit - III

3. a) What are basic requirements of spark ignition system? Describe working o spark ignition system used in a four cylinder petrol engine. **(8**

   b) Why injection system is better than carburetion system? Compare both th system with neat diagram. **(8**

OR

3. a) Explain Transistorized Coil Ignition (TCI) system with neat sketches. **(7**

   b) Write short note on following : **(3×3=9**

   i) MPFI system

   ii) Firing order

   iii) Fuel pump

Unit - IV

4. a) Explain thermodynamic cycle of supercharging with neat sketch. **(8**

   b) What do you understand by scavenging? Explain various scavenging proces in brief. **(8**

OR

4. a) A racing car SI engine is to be converted for a passenger car. What changes will have to be made as regard **(8)**

   i) Valve timing

   ii) Valve lift

   iii) Ignition timing

   iv) A/F ratio supplied, 150 NM, 250 NM, 450mm^2, 50mm, 420rpm, 217 NM, 2.95 kg/hr, 44000 kJ/kg, 0.068 log/sec, 45 K 4.1868 KJ/kg K.

   b) Why cooling of IC engine is essential? What are the effects of under cooling and over cooling of an engine? **(8)**

Unit - V

5. a) What are the effect, of variable compression ratio on power output thermal load. Specific fuel consumption and engine noise? **(8)**

   b) Draw a neat line diagram of a diesel power plant showing all the system with brief description. **(8)**

OR

5. Write short note on following :- **(4×4=16)**

   a) Free piston engine

   b) Effect of compression ratio on power output.

   c) Dual fuel engine.

   d) Rotary engine

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4E4145

Roll No. _____ Total No. of Pages : 3

4E4145

B. Tech. IV-Sem. (Main & Back) Exam; April-May 2017

Mechanical Engineering

4ME6A I. C. Engines

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 26

Instructions to Candidates :-

*Attempt any **five questions**, selecting **one question** from **each unit**. All Questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly.*
Units of quantities used / calculated must be stated clearly.
Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

UNIT - I

1 (a) What are the fundamental differences between SI and CI engines ? **8**

(b) Discuss the differences between ideal and actual valve timing diagrams of a petrol. **8**

OR

1 A two stroke C.I. Engine delivers 5000 kW while using 1000 kW to overcome frictional losses. It consumes 2300 kg of fuel per hour at an air-fuel ratio of 20 to 1. The heating value of fuel is 42000 kJ/kg. Find the
(a) indicated power
(b) mechanical efficiency

(c) indicated thermal efficiency,
(d) brake thermal efficiency.

4×4=16

UNIT - II

2 (a) Explain briefly the process of combustion in S.I. engine and also explain the stages of combustion with the help of P-Q diagram. 8

(b) Describe the phenomenon of detonation in C.I. Engine. 8

OR

2 (a) Write a short note on alternative fuel for I.C. engines. 8

(b) What are the desirable properties of good I.C. engine fuels, 8

UNIT - III

3 Describe with suitable diagram the following systems of a carburettor :
(a) Main metering system.
(b) Idling system.
(c) Power enrichment or economizer system.
(d) Acceleration pump system.

4×4=16

OR

3 (a) State the advantages of electronic ignition system over convectional ignition system. 8

(b) Describe with the help of suitable diagram common rail direct injection system. 8

UNIT - IV

4 (a) Discuss the functions of lubricant in an engine: **8**

(b) Describe the mist lubrication system used for a two stroke engine, **8**

OR

4 (a) Explain water cooling system with suitable diagram. What is the function of fins ? **8**

(b) Explain the methods of supercharging in four stroke engines. **8**

UNIT - V

5 (a) What is a dual fuel engine ? How mixing of fuel takes place. **8**

(b) What is the effect of variable compression ratio on thermal efficiency of the engine ? **8**

OR

5 (a) Explain the working of stratified engine. **8**

(b) What are the requirements of a dual fuel engine ? **8**
