IC ENGINE
(MECH 3211)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) If N is the rpm, number of power strokes/min in a four-stroke engine is
(a) $2N$ (b) $N/2$ (c) N (d) $4N$.

(ii) The main advantage of a two stroke engine over a four stroke engine is
(a) more uniform torque on the crankshaft
(b) more power output for the cylinder of same dimension
(c) absence of valves
(d) all of the above.

(iii) Equivalence ratio is
(a) $\frac{actual\ \ fuel/air\ ratio}{stoic\,hiometric\ \ fuel/air\ ratio}$ (b) $\frac{stoic\,hiometric\ \ fuel/air\ ratio}{actual\ \ fuel/air\ ratio}$
(c) $\frac{stoic\,hiometric\ \ fuel/air\ ratio}{actual\ \ air/fuel\ ratio}$ (d) $\frac{actual\ \ air/fuel\ ratio}{stoic\,hiometric\ \ fuel/air\ ratio}$

(iv) The normal range of compression ratio for a Diesel cycle is
(a) 4 to 6 (b) 6 to 8 (c) 15 to 20 (d) > 25.

(v) Volumetric efficiency is a measure of
(a) engine speed (b) power of engine
(c) pressure rise in cylinder (d) engine breathing capacity.

(vi) Turbocharger engines are those in which the charge density is increased by
(a) separate air compressors
(b) cooling inlet air
(c) compressors driven by exhaust gas turbine
(d) decreasing clearance volume.

(vii) The lubricants commonly used in automobiles are
(a) animal oils (b) mineral oils (c) vegetable oils (d) cooking oils.

(viii) When the spark is advanced, work output is less as
(a) the peak pressure is low
(b) the peak temperature is low
(c) additional work is required to compress the burning gas
(d) frictional losses increase.

(ix) Addition of tetra-ethyl-lead in gasoline is being discontinued as
(a) it has bad odour (b) it is costly
(c) it decreases engine efficiency (d) it blocks the catalytic converter.

(x) The Morse test is applicable only to
(a) single cylinder SI engines (b) single cylinder CI engines
(c) multi-cylinder CI engines (d) both single and multi-cylinder engines.

Group- B

2. (a) Define the (i) indicated thermal efficiency (ii) mechanical efficiency and (iii) brake thermal efficiency. What is the relation between the three?
A diesel engine develops 5 kW. The indicated thermal efficiency is 30% and its mechanical efficiency is 57% . Estimate:
(i) Fuel consumption rate in kg/hr.
(ii) Indicated and Brake specific fuel consumption. [(CO1)(Apply/IOCQ)]

(b) Compare the air-standard Otto, Diesel and Dual combustion cycle for the same compression ratio and the same heat input. [(CO2)(Explain/LOCQ)]

(3 + 5) + 4 = 12

3. (a) The cubic capacity of a four stroke over square spark ignition engine is 245 cc. The over square ratio is 1.1. The clearance volume is 27.2 cc. Calculate bore, stroke and compression ratio of the engine. [(CO1)(Apply/IOCQ)]

(b) Explain 'Time loss factor' in an actual SI engine cycle. Explain in which various areas 'rubbing friction loss' occurs and how they are dependent on engine speed. [(CO2)(Understand/LOCQ)]

4 + (5 + 3) = 12

Group- C

4. (a) Mention three important simplified assumptions used in fuel-air cycle analysis. With the help of a $p - V$ diagram, briefly explain the loss due to variation of specific heats in an Otto cycle. [(CO2)(Understand/IOCQ)]

(b) Briefly explain the following: (i) time loss factor (ii) exhaust blowdown factor. [(CO2)(Explain/LOCQ)]

(3 + 5) + 4 = 12

5. (a) A four-cylinder, four-stroke gasoline engine, having a bore of 10 cm and stroke 9 cm runs at 4000 rpm. The fuel used has a carbon content of 84.50% and hydrogen content 15.50% by weight. The volumetric efficiency of the engine at 75% of full throttle and 4000 rpm is 0.85 referred to 300 K and 1 bar. The

engine is to be supplied with an air fuel mixture when running at 75% of full throttle. Calculate the throat diameter of the venturi if the air velocity at the throat is not to exceed 200 m/s under the above operating conditions. Also calculate the rate of fuel flow in kg/s and the pressure drop at venture throat. Discharge coefficient for the venturi is 0.8 and the area ratio of the venturi is 0.8. Take R for air and fuel vapour as 0.287 kJ/kg-K and 0.090 kJ/kg-K, respectively. [Assume incompressibility condition.] [(CO4)(Analyze/HOCQ)]

(b) Explain very briefly the different stages of combustion in SI engine. [(CO3)(Understand/IOCQ)]

8 + 4 = 12

Group - D

6. (a) Calculate the diameter of the fuel orifice of a 4-stroke engine which develops a brake power of 25 kW per cylinder at 3000 rpm. The bsfc is 0.28 kg/kWh of fuel with 30° API. The fuel is injected at a pressure of 160 bar over a crank travel of 27°. The pressure in the combustion chamber is 45 bar. Coefficient of velocity is 0.875 and specific gravity is given by S.G.=$S.G. = \frac{141.5}{131.5 + °API}$. [(CO4)(Apply/IOCQ)]

(b) Describe briefly the functions of the following in relation to a battery ignition system: ballast resistor, ignition coils, spark plug, dwell angle. [(CO4)(Understand/LOCQ)]

6 + 6 = 12

7. (a) A spray penetration of $20\ cm$ is obtained in $16\ milliseconds$ at an injection pressure of $140\ bar$. If an injection pressure of $220\ bar$ is used, determine the time required by the spray to penetrate the same distance? Assume the same orifice and combustion chamber density. The combustion chamber pressure is $15\ bar$. Use the relation $\boldsymbol{S \propto t\sqrt{\Delta p}}$

$\boldsymbol{S}$: $penetration\ in\ cm$, $\boldsymbol{t}$: $time\ in\ millisecond$, $\Delta\boldsymbol{p}$: $pressure\ difference\ between\ injection\ pressure\ and\ combustion\ chamber\ pressure$

[(CO4)(Analyze/HOCQ)]

(b) Briefly state the interrelation between ignition and combustion.
What are the requirements of an ignition system to ensure reliable working of an engine?
With the help of a block diagram, briefly describe the function of a dry sump lubrication system. [(CO5)(Understand/LOCQ)]

4 + 8 = 12

Group – E

8. (a) Briefly describe the principle of a forced circulation system with the aid of a block diagram. State the principal components of the forced circulation system. [(CO4)(Understand/LOCQ)]

(b) A Morse test on a 12 cylinder, two-stroke compression-ignition engine of bore $40\ cm$ and stroke $50\ cm$ running at $200\ rpm$ give the following readings:

Condition	*Brake load (Newton)*	*Condition*	*Brake load (Newton)*
All firing	2040	7th cylinder	1835
1st cylinder	1830	8th cylinder	1860
2nd cylinder	1850	9th cylinder	1820
3rd cylinder	1850	10th cylinder	1840
4th cylinder	1830	11th cylinder	1850
5th cylinder	1840	12th cylinder	1830
6th cylinder	1855	All firing	2060

The output is found from the dynamometer using the relation $bp = \frac{WN}{180}$, where W is the brake load in Newton and the speed N is in rpm. Calculate:

(i) Total indicated power.

(ii) Mechanical efficiency.

(iii) Brake mean effective pressure. [(CO5)(Apply/HOCQ)]

(3 + 2) + (3 + 2 + 2) = 12

9. (a) A four-cylinder petrol engine running at 1200 rpm delivers a power of 25 kW. When one of the cylinders was cut off, an average torque of 110 Nm was obtained at the same rpm. The calorific value of fuel is 43000 kJ/kg. The engine consumes 360 g of fuel per kWh. Determine the mechanical efficiency and indicated thermal efficiency. [(CO5)(Analyze/IOCQ)]

(b) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 1 bar pressure and 300 K temperature. If the isentropic efficiencies of the compressor and the turbine are 80% and 85% respectively, make calculations for the net work output, cycle efficiency and work ratio. [(CO6)(Apply/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.46	43.75	19.79

After going through the course, the students will be able to:

1. **Demonstrate** knowledge of the operating characteristics of common IC engines and the ability to perform a thermodynamic analysis of Otto, Diesel, and Dual cycle models (**L-3**).
2. **Explain** and quantify the differences in work outputs between theoretical cycles and actual cycles in operation (**L-2**).
3. **Distinguish** between the combustion processes in SI and CI engines and the characteristics of common liquid and gaseous fuels (**L-3**).
4. **Execute** combustion analysis of fuels in the basic cycles as well as quantitative analysis of the air-fuel ratio in a simple carburetor (**L-3**).
5. **Describe** the various performance testing procedures and **recognize** IHP, BHP, FHP and efficiency parameters (**L-2**).
6. **Examine** an ideal gas turbine cycle and calculate thermal efficiency and work output (**L-4**).