

7. (a) A six cylinder, 4-s diesel engine develops a power of 240 kW at 3000 rpm. The *bsfc* is 0.2kg/kWh. At the beginning of injection, cylinder pressure is 35 bar and the maximum cylinder pressure is 55 bar. The injection is expected to be at 180 bar and maximum injection pressure is 520 bar. Take effective pressure difference as the average pressure difference over the injection period. Given the following data:

C_d for injector = 0.75

Sp Gr of fuel = 0.85

Atmospheric pressure = 1 bar

Determine the orifice diameter of each injector assuming each cylinder has one injector and injection continues over 20° of crank rotation.

- (b) What are the requirements of an ignition system? Name the essential components of a battery ignition system.

$$7 + (3 + 2) = 12$$

Group – E

8. (a) Briefly explain the method of measurement of smoke by the comparison method.
- (b) In a gas turbine plant working on Brayton cycle, the inlet air is at 27°C and 0.1MPa. The pressure ratio is 6.25 and the maximum temperature is 800°C. The turbine and compressor efficiencies are 80% each. Find the (i) compressor work, (ii) turbine work, (iii) cycle efficiency, and the (iv) turbine exhaust temperature. Mass of air may be considered as 1kg. Draw the corresponding $T - s$ diagram.

$$4 + (2 + 2 + 2 + 1 + 1) = 12$$

9. (a) A 4-stroke cycle petrol engine has six single acting cylinders of 7.5 cm bore and 9 cm stroke. The engine is coupled to a brake dynamometer having a torque arm radius of 38 cm. At 3300 rpm, with all cylinders firing the net brake load is 324 N. When each cylinder in turn is rendered inoperative, the average net brake load produced at the same speed by the remaining five cylinders is 245 N. Estimate the indicated power and indicated mean effective pressure of the engine.

- (b) Briefly discuss the various parameters that affect the engine heat transfer. Name the major exhaust emissions from an I C engine.

$$(4 + 2) + (4 + 2) = 12$$

IC ENGINES (MECH 3201)

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) Accumulation of carbon deposits on the cylinder head of an IC Engine leads to increase in
- | | |
|-------------------------|-----------------------|
| (a) clearance volume | (b) swept volume |
| (c) piston displacement | (d) compression ratio |
- (ii) The intake charge in a Diesel engine consists of
- | | |
|------------------|------------------------------------|
| (a) air alone | (b) air and lubricating oil |
| (c) air and fuel | (d) air, fuel and lubricating oil. |
- (iii) Volumetric efficiency is a measure of
- | | |
|-------------------------------|--------------------------------|
| (a) engine speed | (b) power of engine |
| (c) pressure rise in cylinder | (d) engine breathing capacity. |
- (iv) Which is the correct statement regarding opening and closing of inlet valve of an actual IC engine?
- | | |
|--|---|
| (a) it opens before TDC and closes after BDC | (b) it opens before TDC and closes before BDC |
| (c) it opens after TDC and closes after BDC | (d) it opens at TDC and closes at BDC. |
- (v) Specific fuel consumption of an IC engine is expressed as
- | | |
|---|---|
| (a) fuel consumption per km of distance travelled | (b) fuel consumption during one hour of running |
| (c) fuel consumption rate for producing unit torque | (d) fuel consumption per unit brake power per hour. |

- (vi) In an air standard Diesel cycle, at a fixed value of r and γ , the efficiency $\eta_{thermal}$
- increases with increase in heat addition and cut-off ratio
 - decreases with increase in heat addition and cut-off ratio
 - remains the same with increase in heat addition and cut-off ratio
 - none of the above.
- (vii) In case of spark ignition engines, at starting
- chemical correct fuel-air ratio is required
 - air and lubricating oil are required
 - air and fuel are required
 - air, fuel and lubricating oil are required.
- (viii) If N is the rpm, the number of power strokes per minute in a four-stroke and two-stroke engine is respectively
- $2N$ and N
 - N and $2N$
 - N and $N/2$
 - $N/2$ and N .
- (ix) Commonly used injection system in automobiles is
- air injection
 - solid injection
 - combination of (a) and (b)
 - none of the above.
- (x) The tendency of petrol to detonate in terms of Octane Number is determined by comparison of the fuel with
- iso-octane
 - mixture of n-heptane and iso-octane
 - mixture of alpha methyl naphthalene
 - mixture of methane and ethane.

Group - B

2. (a) A four-stroke, four-cylinder diesel engine running at 2200 rpm develops 70 kW. The brake thermal efficiency is 32% and the calorific value of the fuel (CV) is 42 MJ/kg. The engine has a bore of 130 mm and stroke of 100 mm. The air density is $\rho_a = 1.15 \text{ kg/m}^3$, air-fuel ratio is 15:1 and the mechanical efficiency is $\eta_m = 0.78$. Calculate (i) fuel consumption rate (kg/s), (ii) air consumption rate (m^3/s), (iii) indicated thermal efficiency, (iv) volumetric efficiency, (v) brake mean effective pressure, and (vi) mean piston speed.
- (b) How do the compression ratio and the equivalence ratio affect the thermal efficiency of a constant volume fuel-air cycle?

8 + (2 + 2) = 12

3. (a) Consider the fuel air cycle of a petrol engine where 1 kg of fuel air mixture contains 1/16 kg of fuel of calorific value of 42 MJ/kg. The mixture has a variable specific heat given as $c_v = (0.678 + 13 \times 10^{-5} T)$ kJ/kg-K; T is in Kelvin. The compression stroke starts at 1 bar, 57°C according to the law $pv^{1.3} = \text{constant}$. The compression ratio is 6. Find the maximum pressure in the cylinder. Compare this value with that obtained with a constant $c_v = 0.717 \text{ kJ/kg-K}$.
- (b) An 80 kW engine has a mechanical efficiency 80%. Assuming the mechanical losses remaining same at all loads, calculate the mechanical efficiency at 60% and 40% loads.

(6 + 2) + 4 = 12

Group - C

4. (a) What is meant by progressive burning and exhaust blowdown loss?
- (b) What is octane number of a SI engine fuel?
- (c) Briefly explain the stages of combustion in SI engines elaborating the flame front propagation.
5. (a) Explain the phenomenon of exhaust gas dilution in the idling range of operation. Explain briefly two important characteristics of CI engine fuel.
- (b) A simple jet carburettor is designed to supply 6 kg of air per minute. The air is at a pressure of 1.013 bar and at a temperature of 27°C. Calculate the throat diameter of the venturi for air flow rate of 108 m/s. Take velocity coefficient to be 0.8. Assume compressible and isentropic flow [Take $R_{air} = 287 \text{ kJ/kg-K}$, $\gamma = 1.4$].

(2 + 2) + 2 + 6 = 12

(3 + 3) + 6 = 12

Group - D

6. (a) List down the functional requirements of a fuel injection system in a CI engine.
- (b) What is meant by dwell angle referred to a battery ignition system?
- (c) A four cylinder, four stroke diesel engine develops 100 kW at 3600 rpm. Its brake specific fuel consumption is 180 gm per kWh. Calculate the quantity of fuel in cc to be injected per cycle per cylinder. Specific gravity of fuel is 0.88.

5 + 2 + 5 = 12