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) Volumetric efficiency of the SI engine is
(a) comparatively lower than that of CI engine
(b) comparatively higher than that of CI engine
(c) same as that of CI engine
(d) same as that of any heat engine

(ii) If L is the stroke length in metre and N is the rpm, mean piston speed of a 2-sroke engine is
(a) LN m/minute (b) LN/2 m/minute
(c) 2LN m/s (d) 2LN m/minute.

(iii) Mist lubrication system is mainly used in
(a) four-stroke petrol engine (b) four-stroke diesel engine
(c) two-stroke petrol engine (d) Wankel engine.

(iv) In evaporative cooling systems, heat absorbed per kg of coolant air is equal to (Δt is temperature difference, c_p and c_v are specific heats at constant pressure and volume respectively)
(a) $c_p \Delta t$ (b) $c_v \Delta t$
(c) latent heat of the coolant (d) $(c_p - c_v) \Delta t$.

(v) Thermal efficiency of CI engine is generally higher than that of SI engine due to
(a) different fuel used
(b) higher compression ratio
(c) constant pressure heat addition
(d) all of these.

(vi) In a reciprocating engine with a cylinder diameter of D and stroke of L, the cylinder volume is
(a) $\frac{\pi}{4} D^2 \times L - clearance\ volume$ (b) $\frac{\pi}{4} D^2 \times L + clearance\ volume$
(c) $\frac{\pi}{4} D^2 \times L \times clearance\ volume$ (d) $\frac{\pi}{4} D^2 \times L \div clearance\ volume$

(vii) For an SI engine, operating with rich mixtures, the optimum spark timing
(a) must be advanced (b) must be retarded
(c) must be at TDC (d) need not be adjusted.

(viii) Which is the wrong statement?
(a) A carburettor prepares a homogeneous air-fuel mixture by atomising and vaporising the fuel
(b) Vacuum at the throat of venturi sucks the fuel through fuel jet
(c) Throttle valve controls the supply of air-fuel mixture
(d) Choke is kept open while cranking a cold engine for starting.

(ix) Radiator is provided to
(a) cool the jacket water
(b) pressurise the cooling water
(c) provide additional water flow
(d) none of the above.

(x) The tendency of petrol to detonate in terms of Octane Number is determined by comparison of the fuel with
(a) iso-octane
(b) mixture of n-heptane and iso-octane
(c) mixture of alpha methyl naphthalene and iso-octane
(d) mixture of methane and ethane.

Group – B

2. (a) Fuel supplied to an SI engine has a calorific value 42000 kJ/kg. The pressure in the cylinder at 30% and 70% of the compression stroke are 1.3 bar and 2.6 bar respectively. Assume that compression follows the law $pv^{1.3}$ = constant. The relative efficiency of the engine compared with the air standard efficiency is 52%. Find (i) the compression ratio (ii) engine efficiency (iii) specific fuel consumption in kg/kW-h.

(b) Explain the effect of variable specific heat in a fuel air cycle of an SI engine and show the effect on p-v diagram.

(4 + 2 + 2) + 4 = 12

3. (a) Make a comparison between a 4- and a 2-stroke cycle engine. What is the difference between a 'Cylinder Row' and a 'Cylinder Bank' in connection with cylinder arrangements?

   (b) A 4-stroke CI engine having a cylinder diameter 40 cm and stroke of 30 cm has a mechanical efficiency of 80%. Assume the friction power as 80 kW. Its fuel consumption is 86 kg/h with an air fuel ratio of 18:1.The speed of the engine is 2000 rpm. Given, η_{ith}= 40% , calculate (i) air consumption rate (ii) indicated power (iii) mean piston speed (iv) calorific value of the fuel (v) p_{imep}.

(3 + 2) + (1 + 1 + 1 + 2 + 2) = 12

Group – C

4. (a) Explain the difference between HCV and LCV of a fuel. Assuming an SI engine fuel to be Octane (C_8H_{18}) and air to contain 23.2% of oxygen by weight, calculate stoichiometric air fuel ratio. What is meant by equivalence ratio (ϕ).

   (b) Briefly explain the phenomenon of 'Ignition Delay' in combustion in CI engines. Compare the phenomenon of 'Knock' in SI and CI engines.

(2 + 3 + 1) + (3 + 3) = 12

5. (a) List down the desirable physical, chemical and combustion properties of an IC engine fuel.

   (b) Discuss briefly ASTM distillation curve with respect to an SI engine fuel.
   A four-cylinder, four-stroke square engine running at 60 revolutions/s has a carburettor ventury with a 4 cm throat. Assuming bore to be 10 cm, volumetric efficiency of 75%, density of air to be 1.15 kg/m^3 and coefficient of air flow to be 0.75, calculate the suction at the throat. Assume incompressibility condition.

(2 + 4) + 6 = 12

Group – D

6. (a) Clearly explain dry sump lubrication system with the help of suitable schematic diagram showing its basic components. What is meant by crankcase ventilation?

   (b) Mention the main components of a typical Solid Injection System in a CI engine with a schematic diagram. Explain the function of 'Ballast Resistor' in a battery ignition system?

(4 + 2) + (3 + 3) = 12

7. (a) Determine the diameter of a fuel orifice for a 4-stroke engine developing 15 kW per cylinder at 2000 rpm, using 0.272 kg/kW-h fuel of 32° API. The duration of injection is 30° of crank rotation. The fuel injection pressure is 120 bar and the average pressure of combustion chamber is 30 bar. Given velocity coefficient is 0.9 and $S.G. = \frac{141.5}{131.5 + °API}$.

   (b) Compare the advantage/disadvantage of a Battery Ignition System in comparison with a Magneto Ignition System. Why is 'Air Injection System' not used now-a-days?

6 + (3 + 3) = 12

Group – E

8. (a) Explain the following: (i) thermosyphon cooling system, (ii) forced circulation cooling system.

   (b) A gasoline engine working on four stroke develops a brake power of 20.9 kW. A Morse test was conducted on this engine and the brake power (in kW) obtained when each cylinder was made inoperative by short-circuiting the spark plug are 14.9, 14.3, 14.8, and 14.5 respectively. The test was conducted at constant speed. The bore of the engine is 75 mm and the stroke is 90 mm. The engine is running at 3000 rpm. Find the indicated power, mechanical efficiency, and brake mean effective pressure when all the cylinders are firing.

(2 + 3) + (4 + 1 + 2) = 12

9. (a) What are the major emissions that come out of an engine exhaust? Briefly discuss any one exhaust emission control method.

   (b) An open-cycle gas turbine plant receives air at 100 kPa and 300 K and compresses it adiabatically to 620 kPa with compressor internal efficiency as 0.88. The fuel has a calorific value of 44.186 MJ/kg and the fuel-air ratio is 0.017 kg of fuel/kg of air. The isentropic efficiency corresponding to the gas turbine is 90%. Calculate the net work output and thermal efficiency of the plant. Take the specific heats at constant volume and at constant pressure are 0.718 kJ/kg-K and 1.005 kJ/kg-K respectively. Assume the values of specific heat are constant throughout the processes and are the same for fresh air and for combustion products.

(2 + 3) + (5 + 2) = 12