

B.E. Power Engineering 3rd Year 2nd Semester Examination 2022

Full Marks: 100

I.C.Engine and Gas Turbine

Time:

Answer any five questions

1. A group of engineering students visited a workshop where they saw a dismantled internal combustion engine.
 - (i) On a closer look, they found a few rings fitted around the engine piston. What are these rings called and what are their types? What are the functions of the rings? [1+3]
 - (ii) The students found the engine to have multiple cylinders. What are the advantages of having a multi-cylinder internal combustion engine over a single cylinder engine of the same rating? How can the cylinders be arranged in a multi-cylinder engine? [3+3]
 - (iii) Power is transmitted from the piston to the crankshaft through connecting rod-crank mechanism. While the crank rotates at a uniform rpm (N), the piston speed continuously changes as the piston reciprocates inside the cylinder. How do you express the mean piston speed? Show that the ratio of instantaneous to mean piston speed is independent of the crank rpm for an engine. [2+8]

2. (i) Two friends studying I.C.Engine are arguing over the efficiencies of a petrol engine and a diesel engine. Finally they decided to find an answer by comparing the air standard cycles of the two engines. They knew that the compression ratios of the two types of engines are not equal. Instead, they tried to compare the corresponding thermodynamic cycles for the same inlet conditions, peak pressure and heat input to get the answer. Can you make a similar comparison and show which engine is more efficient for the conditions chosen? How do the compression ratios of the two cycles compare for the above conditions and is this realistic? [5+2]

- (ii) During the running of an engine it is found that the exhaust valve opens about 30° before the BDC position. A new mechanic working on the engine adjusts the valve timing such that the exhaust valve opens exactly at the BDC position. How will the power output of the engine be affected and why? – Explain with suitable indicator diagrams. [5]

- (iii) A single cylinder four stroke diesel engine running at 1800 rpm has a bore of 85 mm and a stroke of 110 mm works with a mechanical efficiency of 86%. It takes 0.56 kg of air per minute and develops a brake power output of 6 kW while the air-fuel ratio is 20:1. The heating value of the fuel used is 42550 kJ/kg and the ambient air density is 1.18 kg/m³. Calculate, (a) volumetric efficiency, (b) brake specific fuel consumption, (c) indicated thermal efficiency. [8]

3. (i) In the design group meeting of a car manufacturing company one engineer proposes to heat the induction manifold of a petrol car engine to have good evaporation of the fuel. However, others contradict the proposal citing demerits of it. What, in your opinion, can be the demerit and how will it affect the performance of the engine? [4]

(ii) A carburetor in the induction system of a S.I. engine has a throttle valve and a choke valve. Explain the functions of each of the valves in the running of the engine. [6]

(iii) A simple carburetor under a certain condition delivers 5.45 kg/h of petrol with an air-fuel ratio of 15. The fuel jet area is 2 mm^2 with a coefficient of discharge of 0.75. If the tip of the fuel jet is 0.635 cm above the level of petrol in the float chamber and the venturi throat coefficient of discharge is assumed to be 0.80, calculate: (a) the venturi depression to cause air and fuel flow at the desired rates, (b) the venturi throat diameter, (c) the velocity of air through the venturi throat. Take the density of air = 1.29 kg/m^3 and specific gravity of fuel = 0.72. Neglect compressibility of air. [10]

4. (i) The three injectors in the Figure (A) below are for three different types of fuel injection systems in S.I. Engine. Name each of the fuel injection system and compare them with regard to their merits and demerits. [2+6]

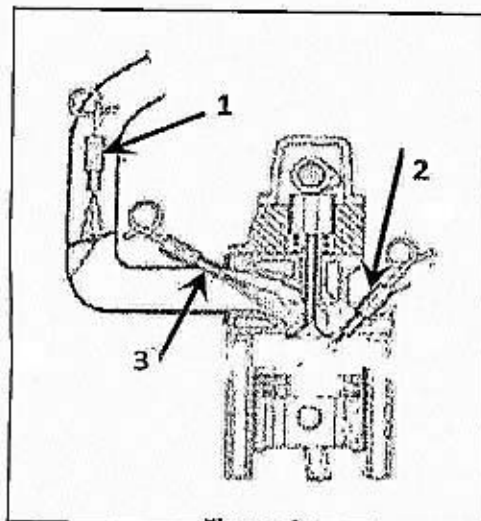


Figure A

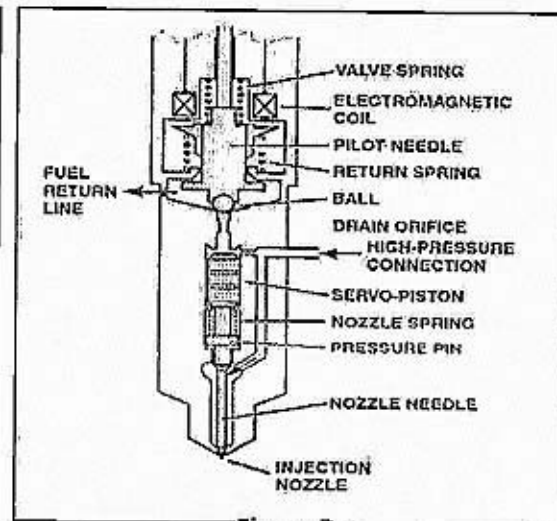


Figure B

(ii) With the help of a schematic diagram explain the differences between the Unit Injection system and Common Rail system with respect to fuel injection in C.I. engines. What are the merits of the Common rail diesel injection system over the other type? [5+2]

(iii) Figure (B) shows the fuel injector assembly of a common rail diesel injection system. Using the figure, explain the process of fuel injection in the cylinder. [5]

5. (i) A spark ignition engine cylinder has a piston with flat top. When the piston is replaced with one having two symmetric lobes on either side of the central axis while maintaining all other things as before, a change in performance of the engine can be observed. What changes in the performance of the engine do you expect with the above modification and why? Explain with justification. [6]

(ii) Draw a representative pressure-crank angle diagram of an operating compression ignition engine and explain the different phases of combustion with it. Also draw the variation of rate of heat release with crank angle for the engine and explain the variation. [5+5]

(iii) Sometimes sharp pinging sound is heard from a running compression ignition engine. What is the reason and what preventive actions would you suggest in the engine to avoid it? [4]

6. (i) A supercharged engine will have higher power output compared to that of a naturally aspirated engine but may not have higher thermal efficiency – Is the statement true? Justify with explanation. [4]

(ii) What is Cetane number of fuel and what is its relevance with respect to the internal combustion engine? [2+2]

(iii) During the trial of a single cylinder, four stroke oil engine the following results were obtained.

Cylinder diameter = 20 cm, stroke = 40 cm, indicated mean effective pressure = 6 bar, brake torque = 507N-m, crank speed=250 rpm, fuel consumption = 4 kg/h, heating value of fuel = 43 MJ/kg, cooling water flow rate = 4.5 kg/min, air-fuel ratio = 30:1, rise in cooling water temperature = 45°C, mean specific heat of exhaust gas = 1 kJ/kg K, specific heat of water = 4.18 kJ/kg K, engine exhaust gas temperature = 422°C, room temperature = 20°C.

Calculate the mechanical efficiency and brake thermal efficiency. Draw up a heat balance sheet for the test on kJ/min basis. [12]

7. (i) Name the fuels commonly used in gas turbine engines for various applications. [3]

(ii) Brayton cycle is the air standard cycle for a gas turbine engine and the thermal efficiency of the Brayton cycle is a function of pressure ratio only. So it is redundant to do research on increasing the turbine inlet temperature (TIT) for a gas turbine engine. Do you agree with the statement? Answer with suitable justifications. [7]

(iii) With a schematic diagram explain the various parts of a turbofan engine and its operating principle. Write down the important requirements in the design of the combustor of a gas turbine engine. [8+2]