MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : ME-601

INTERNAL COMBUSTION ENGINES & GAS TURBINES

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

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

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) The thermodynamic cycle on which gasoline engine works is
   a) Otto cycle b) Joule cycle
   c) Rankine cycle d) Stirling cycle.

ii) During cold starting engine requires
   a) stoichiometric mixture
   b) lean mixture
   c) rich mixture
   d) any A/F ratio is sufficient.

iii) A turbocharger's compressor is
   a) electrically driven
   b) exhaust GT driven
   c) driven by the engine itself
   d) none of these.

iv) The chemically correct air fuel ratio of gasoline is
   a) 10 : 1 b) 15 : 1
   c) 20 : 1 d) 25 : 1.

v) A diesel engine has compression ratio from
   a) 6 to 10 b) 10 to 15
   c) 16 to 20 d) 25 to 40.

vi) Decrease in air-fuel ratio in SI engines results in
   a) increase of NO_x
   b) decrease of CO and UBHC
   c) increase of CO and UBHC
   d) both (a) and (c).

vii) The choke is closed when the engine is
   a) cruising b) hot
   c) idling d) cold.

viii) For the same maximum temperature the efficiency of
   a) otto > dual > diesel b) otto < dual < diesel
   c) otto > diesel > dual d) diesel > dual > otto.

ix) Advantage of fuel injection in SI engine is

a) low maintenance cost

b) low initial cost

c) increased volumetric efficiency

d) low pollution.

x) Detonation in SI engine occurs due to

a) pre-ignition of charge before spark

b) sudden ignition of charge before spark

c) auto ignition of charge after spark

d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What is the difference between air-standard cycle and fuel-air cycle analysis ? Explain the significance of the fuel-air cycle. 3 + 2

3. a) What are the important fuel characteristics considered for good performance in S.I. engine ?

b) A diesel engine has a brake thermal efficiency of 30%. If the calorific value of the fuel is 42,000 kJ/kg, find the brake specific fuel consumption. 3 + 2

4. Explain with sketches the working of a battery ignition system.

5. Explain with sketches the details of a simple gas turbine plant. What are the advances of gas turbine over an I.C. engine ? 3 + 2

6. What is delay period ? What are the factors which affects delay period ? 2 + 3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) In an open cycle constant pressure gas turbine plant, air enters the compressor at a pressure of 1 bar and at a temperature of 27°C and leaves it at a pressure of 5 bar. The gases enter the turbine at a temperature of 627°C. The gases are expanded in the turbine to the initial pressure of 1 bar. The isentropic efficiency of the turbine is 84 per cent and that of the compressor is 86 per cent. Determine the thermal efficiency of the gas turbine plant —

(i) when a regenerator (heat exchanger) with 70 per cent effectiveness (efficiency) is used to preheat the compressed air before it enters the combustion chamber.

(n) if no heat exchanger is used.

Assume no pressure losses in the connecting pipes, combustion chamber and heat exchanger. Take C_p = 1·005 kJ/kg K and γ = 1·4 both for air and gases.

b) What is scavenging ? Explain the various scavenging pumps used in a two-stroke engine.

8 + 7

8. a) Derive an expression for air-fuel ratio of a simple carburetor.

b) A simple jet Carburetor is required to supply 10 kg of air per minute and 0·85 kg of fuel of density 740 kg/m^3. The air is initially at 1·5 bar and 38°C. Calculate the throat diameter of the choke for a flow velocity of 108 m/s. Velocity co-efficient is 0·80. If the pressure drop across the fuel metering orifice is 0·85 of that of the choke, calculate orifice diameter, assuming C_{df} = 0·60.

c) Name and explain different types of sensors used in MPFI system. 6 + 7 + 2

9. a) What are the advantages of supercharger over turbocharger ?

b) What are the limitations of supercharging in an IC engine ?

c) Explain the stages of combustion in an SI engine. What are factors which affect the delay period ?

d) Explain briefly the rating of fuel in SI and CI engine.

e) What is knocking in SI and CI engine ? Compare the knocking phenomenon of SI and CI engine.

10. a) What are the different arrangements used for measuring the BP of an engine. Explain each of the methods of measuring the FP.

b) The following data were obtained from a test on a single-cylinder, 4-stroke, oil engine cylinder : Bore = 15 cm, Stroke = 25 cm, Area of indicator diagram = 450 sq.mm, length of indicator diagram = 50 mm, Indicator spring rating = 1·2 mm for a pressure of 9·81 N/cm^2, engine speed = 400 r.p.m., brake torque = 225 Nm, Fuel consumption = 3 kg/hr, calorific value of fuel = 44,200 kJ/kg, cooling water flow rate = 4 kg/min, cooling water temperature pipe = 42°C. Find out the following :

(i) The mechanical efficiency, (ii) The brake thermal efficiency, (iii) the specific fuel consumption and (iv) draw heat balance.

c) Explain with suitable sketch of valve timing diagram for four-stroke diesel engine. 4 + 8 + 3

11. a) The compression ratio and expansion ratio of an oil engine working on the dual cycle are 9 and 5 respectively. The initial pressure and temperature of the air are 1 bar and 30°C. The heat liberated at constant pressure is twice the heat liberated at constant volume. The expansion and compression follow the law $pV^{1.25}$ = constant. Determine :

(i) Pressures and temperatures at all salient points

(ii) Mean effective pressure of the cycle

(iii) Efficiency of the cycle

(iv) Power of the engine if working cycles per second are 8.

Assume : Cylinder bore = 250 mm and stroke length = 400 mm.

b) Prove that for a given temperature limit (Maximum temperature T_3 and Minimum temperature T_1). the expression of maximum network output $(W_{net})_{max}$ for a closed gas turbine plant is $(W_{net})_{max} = C_p\left(\sqrt{T_3} - \sqrt{T_1}\right)^2$. 8 + 7

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