CS/B.Tech/ME/PE/Even/Sem-6th/ME-601/2015

WEST BENGAL UNIVERSITY OF TECHNOLOGY

ME-601

IC ENGINES AND GAS TURBINES

Time Allotted: 3 Hours   Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1.   Answer *all* questions. $10 \times 1 = 10$

(i) The self ignition temperature of diesel compared to petrol
(A) is higher   (B) is lower
(C) is same   (D) depends on the quality of fuel

(ii) The mixture-requirements of an S.I. engine under normal running on road is
(A) a stoichiometric mixture   (B) a rich mixture
(C) a lean mixture   (D) none of these

(iii) On which factor, out of the following, does volumetric efficiency not depend?
(A) Speed of the engine   (B) Compression ratio
(C) Clearance volume   (D) Cylinder dimensions

(iv) The output of a diesel engine can be increased without increasing the engine revolution or size in the following way
(A) feeding more fuel   (B) increasing flywheel size
(C) heating incoming air   (D) supercharging

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(v) Scavenging air in diesel engine means

(A) air used for combustion sent under pressure

(B) forced air for cooling cylinder

(C) burnt air containing products of combustion

(D) air used for forcing burnt gases out of engine's cylinder during the exhaust period

(vi) The ratio of indicated thermal efficiency to the corresponding air standard cycle efficiency is called

(A) net efficiency   (B) efficiency ratio

(C) relative efficiency   (D) overall efficiency

(vii) Performance mep shows

(A) Indicated power vs speed

(B) bmep vs piston speed under various conditions

(C) η_{bth} vs speed under various conditions

(D) η_{ith} vs speed under various conditions

(viii) Supercharging increases the power output of the engine by

(A) increasing the charge temperature   (B) increasing the charge pressure

(C) increasing the speed of the engine   (D) quantity of fuel admitted

(ix) The compression ratio of an IC engine is the ratio of

(A) swept volume to clearance volume

(B) total cylinder volume to clearance volume

(C) total cylinder volume to swept volume

(D) pressure after compression to that before compression

(x) Automobile engines are usually designed as multi-cylinder engines because with such engines, there is

(A) lower fuel consumption

(B) continuity of power output if one cylinder fails

(C) uniform torque output and better balance

(D) cylinder walls need not be made thick

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. $\qquad$ 3×5 = 15

2. A four-cylinder, four-stroke square engine running at 40 rev/s has a carburettor venturi with a 3 cm throat. Assuming the bore to be 10 cm, volumetric efficiency of 75%, and the 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. $\qquad$ 5

3. Determine the effect of % change in efficiency of Otto cycle having a compression ratio 8 if the specific heat at constant volume increases by 2%. 3+2
   Define air standard efficiency and relative efficiency.

4. A six-cylinder, four stroke petrol engine having a bore of 90 mm and stroke of 100 mm has a compression ratio of 7. The relative efficiency with reference to indicated thermal efficiency is 55% when the indicated specific fuel consumption is 0.3 kg/k Wh. Estimate the caloric value of the fuel and fuel consumption (in kg/h), given that the imep is 8.5 bar and speed is 2500 r.p.m. $\qquad$ 5

5. (a) Discuss the basic principle of MPFI in SI engines. 3
   (b) Define: Delivery ratio and scavenging efficiency. 2

6. (a) A 40 kW engine has a mechanical efficiency of 80%. If frictional power is assumed to be constant with load, what would be the approximate value of mechanical efficiency at 50% of rated load? 3
   (b) The German Mercedes '19D' car possesses a 4-stroke diesel engine with compression of 21:1 and expansion ratio of 10.5:1. What is the cut off ratio? 2

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. $\qquad$ 3×15 = 45

7. (a) 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 $(W_{net})_{max} = C_p\left(\sqrt{T_3} - \sqrt{T_1}\right)^2$. 7+8

   (b) Briefly explain the following :
   (i) Time loss factor
   (ii) Heat loss factor
   (iii) Exhaust blow-down factor.

8. (a) A four-cylinder, four stroke engine running at 2000 rpm has a carburetor venturi with 3.5 cm throat. Assuming the bore to be 12 cm, stroke to be 14 cm, volumetric efficiency 75%, and density of air to be 1.293 kg/m³. Assume coefficient of discharge for air flow to be 0.8. Calculate the suction pressure at the throat.   5+5+5

(b) Explain octane and cetane rating of the fuels and its effects on engines.

(c) Explain any type of ignition system with a neat sketch.

9. (a) In a gas turbine plant, operating on joule cycle, maximum and minimum temperature is 825° C and 25° C respectively. The pressure ratio is 4.5. Calculate the specific work output, cycle efficiency and work ratio. Assume isentropic efficiencies of the compressor and the turbine are at 85 and 90 percent respectively. What is the heat rate in kJ/kW-hr?   10
If the rating of the turbine is 1300 kW, what is the mass flow in kg/sec? Neglect the mass flow of fuel. Given Cp = 1.005 kJ/kgK

(b) Draw the valve timing diagrams for four stroke petrol and diesel engines.   5

10. (a) A simple jet carburetor is required to supply 6 kg of air per minute and 0.45 kg of fuel of density 740 kg/m³. The air is initially at 1.013 bar and 27°C. Calculate the throat diameter of the choke for a flow velocity of 92 m/s. Velocity co-efficient = 0.8. If the pressure drop across the fuel metering orifice is 0.75 of that at the choke, calculate orifice diameter, assuming $C_d = 0.60$.   8

(b) Compare the Otto, Diesel and Dual cycles on the basis of same maximum pressure and Heat input.   3

(c) Briefly explain the following   4
(i) Pumping losses
(ii) Rubbing friction losses.

11. (a) What is fuel air cycle? Discuss with the help of P-V diagram, the effects of (i) variable specific heat and (ii) dissociation on fuel air cycle in respect of an SI engine.   1+3+3

(b) Show that the percentage variation in the efficiency of an ideal diesel cycle due to variation in the specific heat is given by   5+3

$$\frac{d\eta}{\eta} = -\frac{1-\eta}{\eta}(\gamma-1)\frac{dC_v}{C_v}\left[\ln r - \frac{\rho^\gamma \ln \rho}{\rho^\gamma - 1} + \frac{1}{\gamma}\right]$$

Hence calculate the percentage increase/decrease in the efficiency of an ideal diesel cycle having compression ratio r = 18, cut off at 5% of stroke, mean specific heat $c_v = 0.718$ kJ/kg.K, R = 0.287 kJ/kg.K for a 2% increase in specific heat due to temperature rise.