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ENGINEERING & MANAGEMENT EXAMINATIONS, DECEMBER - 200

IC ENGINE & STEAM TURBINE

SEMESTER - 5

Time : 3 Hours] [Full Ma

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 x

i) A 75 c.c. engine has which of the following parameters as 75 c.c. ?

a) Fuel tank capacity b) Lub oil capacity

c) Swept volume d) Cylinder volume

e) Clearance volume.

ii) The size of the inlet valve of an engine in comparison to exhaust valve is

a) more

b) less

c) same

d) more or less depending on capacity of engine

e) varies from engine to engine.

iii) Velocity compounding involves

a) expansion of steam in stages

b) recovery of kinetic energy of steam leaving first set of blades in subsequent rows of blades

c) velocity and pressure equalization at different stages

d) increased velocity after each stage due to expansion of steam

e) none of these.

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v) In Parson's reaction turbine

a) there are no fixed blades

b) there are no moving blades

c) fixed blades are bigger than moving blades

d) moving blades are bigger than fixed blades

e) both fixed and moving blades are identical.

In an SI engine, the high voltage for spark is in the order of

a) 1 kV b) 2 kV

c) 11 kV d) 22 kV.

The fins at the top of a motor cycle engine cylinder are longer than those at the bottom, because

a) hot air rises

b) top is the hottest part

c) they are in an unexposed position

d) extra strength is required at the top.

Supersaturated flow through steam nozzle leads to

a) decrease in available enthalpy drop

b) increase in available enthalpy drop

c) decrease in temperature compared to that for stable flow

d) increase in temperature compared to that for stable flow.

Axial shift in steam turbines occurs due to

a) wearing away of thrust bearing or pad

b) unequal expansion of rotor and casing

c) no axial shift is possible since it is a rotating machine

d) none of these.

ix) The dryness fraction is limited to 88 to 90% at any stage in steam turbine t prevent

a) fall in thermal efficiency b) corrosion of blades
c) erosion of blades d) overloading of condenser.

x) Cetane

a) has zero cetane number b) has 100 cetane number
c) helps detonation d) is a straight chain paraffin
e) both (b) and (d).

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 1

2. With respect to Air Standard cycles

$\eta_{otto} > \eta_{dual} > \eta_{diesel}$

Explain using cycle diagram.

3. A six cylinder four stroke engine develops 125 kW at 3000 rpm. Its brake specific fue consumption is 200 gm/kW-hr. Calculate the quantity of fuel to be injected per cyc per cylinder. Specific gravity of fuel = 0.85.

4. Show that the diagram work per unit mass of steam for maximum blading efficiency a 50% reaction stage is V_b^2, where V_b is the mean blade velocity.

5. Show that the air-fuel ratio for a simple carburetor is

$$\frac{A}{F} = 0.1562 \frac{C_{da} A_2}{C_{df} A_f} \frac{p_1 \phi}{\sqrt{2T_1 \rho_f (p_1 - p_2 - g z \rho_f)}}$$

6. The velocity of steam entering a simple impulse turbine is 1000 m/s and the nozz angle is 20°. The mean peripheral velocity of blades is 400 m/s and the blades ar symmetrical. If the steam is to enter the blades without shock, what will be the blad angles ?

a) Neglecting the friction effects on the blades, calculate the tangential force on th blades and the diagram power for a mass flow of 0.75 kg/s. Estimate also th axial thrust and the diagram efficiency.

b) If the relative velocity at exit is reduced by friction to 80% of that at inle estimate the axial thrust, diagram power and diagram efficiency.

GROUP – C

(Long Answer Type Questions)

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

2) The following particulars refer to a two row velocity compounded impulse wheel.

Steam velocity at nozzle exit : 600 m/s

Nozzle angle : 16°

Mean blade velocity : 120 m/s

Exit angles : first row of moving blades = 18°, fixed guide blade = 22°, second row moving blades = 36°

Steam flow : 5 kg/s, blade velocity co-efficient : 0.85,

Calculate :

i) The tangential thrust

ii) The axial thrust

iii) Power developed

iv) Diagram efficiency. 7

b) An adiabatic steam nozzle is to be designed for a discharge rate of 10 kg/s of steam from 10 bar and 400°C to a back pressure of 1 bar. The nozzle efficiency is 0.92 and the frictional loss is assumed to take place in the diverging portion of the nozzle only. Assume a critical pressure ratio of 0.5457. Determine the throat and exit areas. 8

c) In a stage of an impulse turbine provided with a single row wheel, the mean diameter of the blade ring is 80 cm and speed of rotation is 3000 r.p.m. The steam issues from the nozzles with a velocity of 300 m/sec and the nozzle angle is 20°. The rotor blades are equiangular and due to friction in the blade channels the relative velocity of steam at outlet from the blades is 0.86 times the relative velocity of steam entering the blades. What is the power developed in the blades when the axial thrust on the blades is 140 N ? 9

d) During the trial of a single cylinder, four stroke oil engine, the following results were obtained :

Cylinder dia = 20 cm, stroke = 40 cm, *mep* = 6 bar, torque = 407 Nm, N = 250 rpm, oil consumption = 4 kg/h, CV_{fuel} is 43000 kJ/kg, cooling water flow rate = 4.5 kg/min, air used per kg of fuel = 30 kg, rise in cooling water temperature = 45°C, temperature of exhaust gases = 420°C, room temperature = 20°C, mean specific heat of exhaust gas = 1 kJ/kg-K, specific heat of water = 4.18 kJ/kg-K.

Find IP, BP and draw up a heat balance sheet for the test. 6

9. a) A Parsons reaction turbine running at 400 rpm develop[s] MW using 6 kg-k[s] of steam flow. The exit angle of the blades is 20° and the velocity of ste[am] relative to the blades at exit is 1.35 times the mean blade speed. At a particu[lar] stage in the expansion, the pressure is 1.2 bar and the steam quality is 0.[9] Calculate for this stage :

i) a suitable blade height, assuming the ratio of D_m/h_b as 12, and

ii) diagram power.

b) A simple jet carburetor is required to supply 5 kg of air and 0.5 kg of fuel [per] minute. The fuel specific gravity is 0.75. The air is initially at 1 bar and 300 [K]. Calculate the throat diameter of the choke for a flow velocity of 100 m/s. Velocity coefficient is 0.8. If the pressure drop across the fuel metering orifice is 0.8 of that of the choke, calculate orifice diameter assuming $C_{df} = 0.6$, $\gamma = 1.4$.

10. a) Fuel supplied to an SI engine has a calorific value 42,000 kJ/kg. The pressu[re] in the cylinder at 30% and 70% of the compression stroke are 1.3 bar a[nd] 2.6 bar respectively. Assume that the compression follows the l[aw] $pv^{1.3}$ = constant. Find the compression ratio. If the relative efficiency of t[he] engine compared with the air standard efficiency is 50%, calculate the fu[el] consumption in kg/kWh.

b) Taking the variation in specific heats into account derive the following expressi[on] for Diesel engine :

$$\frac{d\eta}{\eta} = -\frac{1-\eta}{\eta}(\gamma - 1)\left[\log_e r - \frac{\rho^\gamma \log_e \rho}{\rho^\gamma - 1} + \frac{1}{\gamma}\right]\frac{dc_v}{c_v}.$$

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