Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH (ME)/SEM-5/ME-501/2011-12
2011
IC ENGINE AND STEAM TURBINE

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 Choic   Type Questions)

1.   Choose the correct alte natives for the following :

$10 \times 1 = 10$

i)   The degree of reaction of Parsons turbine is

a)   0·75   b)   1·0

0·5   d)   0·25.

ii)   Transfer port is used in case of

a)   SI engine

b)   CI engine

c)   two-stroke engine

d)   four-stroke engine.

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iii) Velocity compounding involves

    a)   expansion of steam in stages

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

    c)   velocity and pressure equalization at different stages

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

iv) Gudgeon pin forms the link between

    a)   Piston and big end of the connecting rod

    b)   Piston and small end of the connecting rod

    c)   Connecting rod and c ank

    d)   Big end and mal end.

v) The dryness fraction of steam in a turbine is limited to 85% to 90% to prevent

    a)   fall in thermal efficiency

    b)   corrosion of blades

    c)   erosion of blades

    d)   overloading of condenser.

vi) Lean air mixture is required during

    a)   Idling   b)   Starting

    c)   Accelerating   d)   Cruising.

vii) 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.

viii) Supercharging or turbo charging increases the power output of the engine by

a) increasing the charge temperature

b) increasing the charge mass by increasing the density

c) increasing the speed of the engine

d) none of these.

ix) For multistage steam turbine, reheat factor is defined as

a) $\eta_{stage} \propto \eta_{n\ zzle}$

b) cumulative enthalpy drop $\propto \eta_{nozzle}$

c) $\dfrac{\text{cumulative isentropic enthalpy drop}}{\text{ideal enthalpy drop}}$

d) $\dfrac{\text{isentropic enthalpy drop}}{\text{cumulative actual enthalpy drop}}$.

x) Detonation in a SI Engine occurs due to the

a) pre-ignition of the charge before the spark

b) sudden ignition of the charge before the spark

c) auto ignition of the charge after the spark

d) none of these.

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GROUP – B

(Short Answer Type Questions)

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

2. With a neat sketch, explain the working principle of a simple carburettor.

3. With respect to air standard cycle for the same compression ratio and heat input $\eta_{Otto} > \eta_{dual} > \eta_{diesel}$. Explain using the cycle diagrams on *p-v* and *T-S* plots.

4. Define volumetric efficiency. Explain how it is important related to the performance of the IC engines. Mention the factors that affect volumetric efficien y.

5. What is the need of compounding in the case of impulse turbine ? Show with a neat sketch how the pressure and velocity of steam varies across the stages of the velocity compounded impulse tu bine.

6. How do you define he degree of reaction of a reaction steam turbine ? Prove that the degree of reaction of a Parson's reaction turbine is

$$R = \frac{V_f}{2\,U} \left(\cot \beta_2 - \cot \beta_1 \right) .$$

GROUP – C

(Long Answer Type Questions)

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

7. a) Develop a relation between stage efficiency, internal efficiency and reheat factor of a multistage turbine.   6

b) Steam enters a 50% reaction turbine at 14 bar & 315C and is expanded to a pressure of 0·14 bar. The turbine has a stage efficiency of 75% for each stage and reheat factor is 1·04. The turbine has 20 successive stages and total power output is 12 MW. At a certain place in turbine, the steam has a pressure of 1 bar and dry saturated. The exit engle of blade is 20 degree and blade speed ratio is 0·7. The blade height is 1/12 of the mean blade diameter. Calculate

   i)   steam flow rate assuming all stages develop equal work

   ii) mean diameter of the annulus at this point of turbine

   iii) rotor speed.   9

8. a) Why is axial thrust generated in steam turbine ? Discuss the diffe ent methods of balancing the axial thrust in steam urbines.   1 + 4

   b) A velocity compounded impulse turbine has 2 rows of moving blades with a fixed row of guide blades. The steam leaves the nozzle at 900 m/s in a direction at 18° to the plane of rotation. The blade speed is 150 m/s and the blade outlet angles are 24°, 26° and 30° for the first moving, first fixed and second moving respectively. The friction factor is 0·9 for all rows. The steam supply is 4500 kg/hr. Determine

   i)   tangential force on the rotor

   ii) total work done on the blades

   iii) power developed by the turbine.   10

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9. a) What do you mean by a de-Laval nozzle ? 1

b) Prove that the condition of maximum discharge through nozzle is given by $\dfrac{P_2}{P_1} = \left(\dfrac{2}{n+1}\right)^{\frac{n}{n-1}}$, where P_2 is the pressure at throat and P_1 is the inlet pressure. 6

c) Explain the effects of the following on the actual indicator diagram of an SI engine :

   i) Time loss factor

   ii) Heat loss factor

   iii) Exhaust blowdown factor. 8

10. a) What are the different stages of ombustion in a CI engine ? 2

b) Explain the effects of compre sion ratio and engine speed on the first stage of combustion in a CI engine.

4

c) A four-stroke four cylinder diesel engine running at 2000 r.p.m. develops 60 KW. Brake thermal efficiency is 30% and calorific value of fuel is 42 MJ/Kg. Engine has a bore of 120 mm and stroke of 100 mm. Take, air density = 1 15 kg/m^3 , air-fuel ratio = 15 : 1 and mechanical efficiency = 0·8. Calculate

   i) fuel consumption (kg/s)

   ii) air consumption (kg/s)

   iii) indicated thermal efficiency

   iv) volumetric efficiency

   v) brake mean effective pressure

   vi) mean piston speed. 9

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11. a) What is 'petrol injection' ? Discuss the advantages and disadvantages of petrol injection system over the carburettor system.   1 + 4

b) What are the advantages and limitations of supercharging in an IC engine ?   3

c) Fuel supplied to an SI engine has a calorific value 42,000 KI/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 the compressi n follows the law $PV^{1.3}$ = constant. Find the compression ratio. If the relative efficiency of the engine compa ed with the air standard efficiency is 50%, calculate the fuel consumption in kg/KWh   7