CBCS SCHEME

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21ME52

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2025
Thermo-Fluids Engineering

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain any two methods of determining frictional power. **(08 Marks)**

b. The following observations were made during a trial of a single cylinder, four stroke cycle gas engine having cylinder diameter of 18 cm and stroke 24.
Duration of trial = 30 min
Total number of revolution = 9000
Total number of explosion = 4450
Mean effective pressure = 5 bar
Net load on the brake wheel = 40 kg
Effective diameter of brake wheel = 1 m
Total gas used at NTP = 2.4 m^3
Calorific value of gas at NTP = 19 MJ/m^3
Total air used = 36 m^3
Pressure of air = 720 mm of Hg
Temperature of air = 17°C
Density of air at NTP = 1.29 kg/m^3
Temperature of exhaust gas = 350°C
Room temperature = 17°C
Specific heat of exhaust gas = 1 KJ/kg K
Cooling water circulated = 80 kg
Rise in temperature of cooling water = 30°C
Draw up a heat balance sheet and estimate the mechanical and indicated thermal efficiencies of the engine. Take R = 287 J/kg K. **(12 Marks)**

OR

2 a. Derive an expression for minimum work input by two stage compressor with perfect intercooling. **(10 Marks)**

b. A single cylinder double acting air compressor is required to deliver 100 m^3/min of air at a mean piston speed of 500 m/min measured at 1 bar and 15°C. The air is delivered at 7 bar. Assume a clearance volume $1/15^{th}$ of swept volume per stroke. Find volumetric efficiency, speed, bore, stroke, for following two conditions:
(i) If ambient and suction conditions are the same.
(ii) If ambient and suction conditions are different.
Ambient pressure = 1 bar, Ambient temperature = 15°C, Suction pressure = 0.98 bar, Suction temperature = 30°C. Assuming L/D = 1.25. **(10 Marks)**

Module-2

3 a. With a neat sketch, clearly describe the working of a Bell-Coleman cycle. **(06 Marks)**

b. Write a brief note on properties of refrigerants. **(04 Marks)**

c. A 5 ton R-12 refrigeration plant has saturated suction temperature of – 5°C. The condensation takes place at 32°C. Assuming isentropic compression, find
(i) C.O.P of the plant
(ii) Mass flow rate of the refrigerant
(iii) Power required to run the compressor in KW.
Take the following properties of R-12.

Pressure	Temperature °C	h_f KJ/kg	h_g KJ/kg	S_g KJ/kg K
7.85	32	130.5	264.5	1.542
2.61	-5°C	-	249.3	1.557

Take C_p superheated vapour = 0.615 KJ/kg K. **(10 Marks)**

OR

4 a. Define the following :
(i) Dry bulb temperature (ii) Dew point temperature
(iii) Relative humidity (iv) Specific humidity
(v) Degree of saturation. **(10 Marks)**

b. An air-conditional system is to be designed for a hall of 200 seating capacity when the following conditions are given:
Atmospheric condition = 30°C DBT and 50% RH
Indoor condition = 22°C DBT and 60% RH
The required condition is achieved first by chemical dehumidification and after that by sensible cooling.
Find the following :
(i) DBT of the air leaving the dehumidifier.
(ii) The quantity of water vapour removed in the dehumidifier per hour.
(iii) The capacity of cooling coil in tons of refrigeration.
(iv) Surface temperature of the coil if the bypass factor of the coil is 0.25. **(10 Marks)**

Module-3

5 a. With neat sketch explain basic constructional details of turbomachines. **(04 Marks)**

b. Define degree of reaction and utilization factor. Establish the relationship between them. **(06 Marks)**

c. Air enters an axial flow turbine with a tangential component of the absolute velocity equal to 600 m/s in the direction of rotation. At the rotor exit, the tangential component of the absolute velocity is 100 m/s in a direction opposite to that of rotational speed. The tangential blade speed is 250 m/s. Evaluate,
(i) The change in total enthalpy of air between the inlet and outlet of the rotor.
(ii) The power in KW if the mass flow rate is 10 kg/s
(iii) The change in total temperature across the rotor. **(10 Marks)**

OR

6 a. Give classification of positive displacement machines and compare positive displacement machines with turbomachines. **(10 Marks)**

b. With neat sketch explain construction and working of reciprocating pump. **(10 Marks)**

Module-4

7 a. Sketch and explain the working principle of Pelton wheel. **(06 Marks)**

b. What is draft tube? Explain the types and functions of the draft tube. **(06 Marks)**

c. A propeller turbine runner has an outer diameter of 4.5 m and inner diameter of 2 m. It develops 20580 KW when running at 140 RPM under a head of 20 m. The hydraulic efficiency is 94% and the overall efficiency is 88%. Find the discharge through the turbine and guide blade at inlet. **(08 Marks)**

OR

8 a. With respect to centrifugal pump define the following :
(i) Static head (ii) Delivery head (iii) Manometric head
(iv) Manometric efficiency (v) Net positive suction head **(10 Marks)**

b. Centrifugal pump has an impeller diameter of 25 cm and width of 7.5 cm at exit. It delivers 120 litres per second of water against ahead of 24 m at 1440 RPM. Assuming the vane blocks the area of the flow by 5% and hydraulic efficiency of 0.85, estimate the angle at exit. Also calculate the torque exerted on the driving shaft if the mechanical efficiency is 95%. **(10 Marks)**

Module-5

9 a. Explain the following with respect to centrifugal compressor:
(i) Pressure coefficient (ii) Slip factor
(iii) Power factor (iv) Surging and choking **(12 Marks)**

b. A centrifugal compressor has an inlet eye 15 cm diameter. The impeller revolves at 20,000 RPM and the inlet air has an axial velocity of 107 m/s, inlet stagnation temperature and pressure are 294 K and 1.03 bar respectively. Determine
(i) The theoretical angle of the blade at this point and
(ii) Mach number of the flow at the tip of the eye. **(08 Marks)**

OR

10 a. Draw inlet and outlet velocity triangles of a two-stage impulse turbine and derive expression for work done. **(10 Marks)**

b. A single stage impulse turbine has a diameter of 1.5 m and running at 3000 RPM. The nozzle angle is 20°. The speed ratio is 0.45. Ratio of relative velocity at the outlet to that at inlet is 0.9. The outlet angle of the blade is 30 less than the inlet angle. Steam flow rate is 6 kg/s. Draw the velocity diagrams and find the following :
(i) Velocity of whirl (ii) Axial thrust (iii) Blade angles and (iv) Power developed. **(10 Marks)**

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