CBCS SCHEME

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21ME52

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Thermo-Fluids Engineering

Time: 3 hrs. Max. Marks: 100

Note:1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. Use of thermodynamic data hand book is permitted.

Module-1

1 a. With suitable formulae, explain Morse test for measuring frictional power in an IC engine. **(05 Marks)**

b. What are the parameters to be considered while framing heat balance sheet for an IC engine? **(05 Marks)**

c. The following data refers to a four stroke diesel engine :
Cylinder diameter = 200 mm,
Stroke = 300 mm, Speed = 300 rpm,
Effective brake load = 500 kg,
Mean circumference of the brake drum = 400 mm,
Mean effective pressure = 6 bar,
Diesel consumption = 0.1 lt/min,
Calorific value = 43900 kJ/kg,
Specific gravity = 0.78.
Find :
(i) Brake power
(ii) Indicated power
(iii) Frictional power
(iv) Mechanical efficiency
(v) Indicated thermal efficiency. **(10 Marks)**

OR

2 a. Explain the procedure of conducting experiment to evaluate the performance of a reciprocating 2 stage air compressor. **(06 Marks)**

b. With the help of PV diagram, derive an expression for the volumetric efficiency in terms of clearance ratio for a 2 stage reciprocating air compressor. **(06 Marks)**

c. A double acting air compressor of 18 cm diameter and 120 cm stroke runs at 120 rpm and operates between 1 bar and 10 bar, the lower temperature being 15°C. Estimate the power, final temperature and temperature rise, if the compression index = 1.3. **(08 Marks)**

Module-2

3 a. With a neat sketch, explain vapor absorption refrigerator. **(06 Marks)**

b. Mention a few properties of a good refrigerant. **(04 Marks)**

c. An air refrigerator was designed to produce 80 tons of refrigeration, with air entering the compressor at 8°C. The air was cooled after compression in a cooler to 27°C. It was observed that the actual power required was 20% more than theoretical power with an air circulation rate of 2 kg/s. Determine (i) The theoretical COP (ii) Actual COP (iii) Power required to run the compressor. Assume r = 1.4, C_P = 1.005 kJ/kgK for air and the cycle is ideal. **(10 Marks)**

OR

4 a. Define the terms :
(i) Dew point temperature.
(ii) Dry bulb temperature.
(iii) Wet bulb temperature.
(iv) Humidity ratio.
(v) Relative humidity. **(10 Marks)**

b. An auditorium of 150 seating capacity is conditioned for the following specifications:
Outdoor conditions = 40°C DBT and 20°C WBT,
Required indoor conditions = 20°C DBT and 60% RH.
Amount of outdoor air supplied = 0.4 m^3/min per person.
If the required condition is achieved first by adiabatic humidification and then by cooling.
Calculate : (i) Capacity of the cooling coil in tones
(ii) The capacity of the humidifier in kg/min. **(10 Marks)**

Module-3

5 a. With a neat sketch, explain various parts of turbomachine. **(06 Marks)**

b. With the proper velocity triangles derive an expression for alternate form of Euler's turbine equation. **(06 Marks)**

c. The velocity of steam in a De-Laval turbine at the inlet is 1200 m/s. The nozzle angle at the inlet is 22° and rotor blades are equiangular. Assuming relative velocities of the fluid at the inlet and exit to be equal and tangential speed of the rotor is 400 m/s. Determine
(i) The blade angles at the inlet and exit.
(ii) Power developed if mass flow rate is 1 kg/s.
(iii) Tangential force exerted on the blade ring
(iv) Utilization factor. **(08 Marks)**

OR

6 a. Compare turbomachines and positive displacement machines. **(06 Marks)**

b. With a neat sketch, explain the working of a gear pump. **(06 Marks)**

c. In a radial inward flow turbine, the runner outer diameter is 75 cm and the inner diameter is 50 cm. The runner speed is 400 rpm. Water enters the runner at a velocity of 15 m/s at an angle of 15° to wheel tangent at inlet. The flow is radial at exit with a velocity of 5 m/s. Find the blade angles at inlet and exit. Also determine the power output for flow rate of 1.5 m^3/s, degree of reaction and utilization factor. **(08 Marks)**

Module-4

7 a. Explain the experimental procedure to evaluate the efficiency of a Pelton wheel. **(06 Marks)**

b. Derive an expression for hydraulic efficiency of a Pelton turbine. **(06 Marks)**

c. The external and internal diameters of inward flow reaction turbine are 1.2 m and 0.6 m respectively. The head on turbine is 22 m and velocity of flow through the turbine is constant and is equal to 2.5 m/s. The guide blade angle is 10° and runner vanes are radial at inlet. If the discharge at outlet are radial. Determine
(i) Speed of turbine
(ii) Vane angle at outlet of runner.
(iii) Velocity triangles at inlet and exit
(iv) Hydraulic efficiency. **08 Marks)**

OR

8 a. Derive expression for theoretical head capacity relationship of a centrifugal pump for different vane angles. **(08 Marks)**

b. With a sketch, show different parts of a centrifugal pump. **(04 Marks)**

c. A centrifugal pump is designed to run at 1450 rpm. With minimum discharge of 1800 litres/min against a total head of 20 m. The suction and delivery pipes are designed such that they are equal in size of 100 mm. If the inner and outer diameters of the impeller are 12 cm and 24 cm respectively. Determine the blade angles β_1 and β_2 for radial entry neglecting friction and other losses. **(08 Marks)**

Module-5

9 a. Briefly explain the terms in relation with a centrifugal compressor,

(i) Diffuser

(ii) Slip factor. **(06 Marks)**

b. Derive an expression for pressure ratio of a centrifugal compressor. **(06 Marks)**

c. A centrifugal compressor delivers 30 kg/s of air with a total head pressure ratio of 4 : 1. The speed of the compressor is 12000 rpm, inlet total temperature is 15 °C, stagnation pressure at inlet 1 bar, slip factor is 0.9, power input factor is 1.04, efficiency 80%. Calculate the outer diameter of the impeller. **(08 Marks)**

OR

10 a. Derive an expression for maximum blade efficiency for impulse turbine. **(10 Marks)**

b. A simple impulse turbine has a mean blade speed of 200 m/s. The nozzles are inclined at 20° to the plane of rotation of the blades. The steam velocity from nozzles is 600 m/s. The turbine uses 3500 kg/hr of steam. The absolute velocity at exit is along the axis of the turbine. Determine, (i) Inlet and exit angles of blades (ii) Power output of turbine (iii) Diagram efficiency. **(10 Marks)**

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