CBCS SCHEME

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21ME52

Fifth Semester B.E. Degree Examination, June/July 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 steam tables and thermodynamics Data Hand Book is permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain clearly how the frictional power of a multi cylinder Internal Combustion Engine can be determined through Morse Test. **(10 Marks)**

b. The following data were obtained from a Morse test on a 4 cylinder 4 stroke cycle SI engine coupled to a hydraulic dynamometer operating at a constant speed of 1500 rpm :
Brake load with all 4 cylinders firing = 296 N,
Brake load with cylinder 1 not firing = 201 N,
Brake load with cylinder 2 not firing = 206 N,
Brake load with cylinder 3 not firing = 192 N,
Brake load with cylinder 4 not firing = 200 N.

The brake power in kW is calculated using the equation $BP = \frac{WN}{42300}$, where W = Brake load in Newton, N = Speed of the engine in rpm. Calculate :
(i) Brake power (ii) Indicated power
(iii) Frictional power (iv) Mechanical efficiency **(10 Marks)**

OR

2 a. Obtain an expression for the volumetric efficiency of a single stage reciprocating air compressor in terms of the pressure ratio, the clearance ratio and the index of expansion. **(10 Marks)**

b. Air at 1 bar and 27°C is compressed to 7 bar by a single stage reciprocating compressor according to the law $Pv^{1.3}$ = constant. The free air delivered was $1 m^3/min$. Speed of the compressor is 300 rpm. Stroke to bore ratio is 1.5 : 1. Mechanical efficiency is 85% and motor transmission efficiency is 90%. Determine :
(i) Indicated power and isothermal efficiency
(ii) Cylinder dimensions and power of the motor required to drive the compressor. **(10 Marks)**

Module-2

3 a. Define the following terms with respect to refrigeration :
(i) Refrigerating effect.
(ii) Unit of refrigeration.
(iii) COP. **(06 Marks)**

b. With the help of a neat sketch, explain the working principle of a vapour absorption refrigeration system. **(08 Marks)**

c. In an air refrigeration plant working on a reversed Brayton cycle, air enters the compressor at 1 bar and $-15^{\circ}C$ where it is compressed to a pressure of 5.5 bar. Air enters the expander at $15^{\circ}C$. Determine :
(i) COP of the cycle
(ii) Mass flow rate of air into the compressor per minute for one ton of refrigeration. Assume both compression and expansion processes as isentropic. **(06 Marks)**

OR

4 a. Define the following terms with respect to psychrometry :
(i) Specific humidity
(ii) Relative humidity. **(04 Marks)**

b. With a neat sketch, explain the working of summer air conditioning system for hot and dry weather. Represent the processes involved on a psychrometric chart. **(08 Marks)**

c. Atmospheric air at 1.01325 bar has $30^{\circ}C$ DBT and $15^{\circ}C$ DPT. Without using the psychrometric chart, using the property values from the tables, calculate
(i) Partial pressure of air and water vapour (ii) Specific humidity (iii) Relative humidity
(iv) Enthalpy of moist air. **(08 Marks)**

Module-3

5 a. Define a turbo machine. Differentiate between a turbo machine and a positive displacement machine. **(08 Marks)**

b. Identify the following as power generating on power absorbing turbomachine :
(i) Francis turbine (ii) Centrifugal blower
(iii) Centrifugal compressor (iv) De-Laval turbine. **(04 Marks)**

c. With inlet and outlet velocity triangles and with usual notations, derive the alternate form of Euler's turbine equation for a general turbo machine. **(08 Marks)**

OR

6 a. Describe the principle and working of a reciprocating pump with a neat sketch. **(08 Marks)**

b. Define the following terms with respect to reciprocating pump :
(i) Slip (ii) Percentage slip (iii) Negative slip. **(06 Marks)**

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

Module-4

7 a. Define the following efficiencies of a hydraulic turbine :
(i) Hydraulic efficiency
(ii) Mechanical efficiency
(iii) Overall efficiency. **(06 Marks)**

b. Explain the different parts and functioning of a Kaplan turbine with the help of a sectional arrangement diagram. **(06 Marks)**

c. A three jet Pelton wheel is required to generate 10,000 kW under a head of 400 m. The blade angle at outlet is 15° and the reduction in the relative velocity over the buckets is 5%. If the overall efficiency = 80%, $C_v = 0.98$ and speed ratio = 0.46, find : (i) Diameter of each jet (ii) Total flow rate (iii) Force exerted by a jet on the buckets. **(08 Marks)**

OR

8 a. What is Cavitation? What are the causes of Cavitation? What are steps to be taken to reduce the effect of Cavitation? **(04 Marks)**

b. Explain with flow diagram, the purpose of multi stage pump when connected in,
(i) Series (ii) Parallel. **(08 Marks)**

c. A Centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is 45°. The velocity of flow at the outlet is 2.5 m/s. The discharge through the pump is 0.2 m^3/s when the pump is working against a head of 20 m. If the manometric efficiency is 80%, draw the outlet velocity diagram and calculate :
   (i) The diameter of the impeller at the outlet.
   (ii) Width of the impeller at the outlet. **(08 Marks)**

Module-5

9 a. Define the following with respect to centrifugal compressor :
(i) Power input factor (ii) Pressure coefficient (iii) compressor efficiency. **(06 Marks)**

b. Explain the following with appropriate sketches :
(i) Surging. (ii) Choking. **(06 Marks)**

c. A centrifugal compressor runs at a speed of 15000 rpm and delivers 30 kg/s of air. The exit diameter is 70 cm. The relative velocity at exit is 100 m/s at an exit angle of 75°. Assume axial inlet and consider the inlet total temperature as 300 K, inlet total pressure as 1 bar. Determine :
(i) Power required to drive the compressor (ii) Ideal head developed
(iii) Work done (iv) Total exit pressure **(08 Marks)**

OR

10 a. Explain the following methods of compounding of steam turbines :
   (i) Velocity compounding
   (ii) Pressure compounding. **(10 Marks)**

b. A single stage impulse turbine rotor has a diameter of 1.2 m running at 3000 rpm. The nozzle angle is 18°. The blade speed ratio is 0.42. The ratio of the relative velocity at outlet to the relative velocity at inlet is 0.9. The outlet angle of the blade is 3° less than the inlet angle. Steam flow rate is 5 kg/s. Draw the velocity triangles and find :
   (i) Blade angles
   (ii) Axial thrust on bearing
   (iii) Power developed
   (iv) Blade efficiency. **(10 Marks)**

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