

# CBCS SCHEME



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.

### 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  $P\gamma^{1.3} = \text{constant}$ . The free air delivered was 1m<sup>3</sup>/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  $-15^{\circ}\text{C}$  where it is compressed to a pressure of 5.5 bar. Air enters the expander at  $15^{\circ}\text{C}$ . Determine :
- COP of the cycle
  - 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 :
- Specific humidity (04 Marks)
  - 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  $30^{\circ}\text{C}$  DBT and  $15^{\circ}\text{C}$  DPT. Without using the psychrometric chart, using the property values from the tables, calculate
- Partial pressure of air and water vapour
  - Specific humidity
  - Relative humidity
  - 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 or power absorbing turbomachine :
- Francis turbine
  - Centrifugal blower
  - Centrifugal compressor
  - 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 :
- Slip
  - Percentage slip
  - 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 :
- Hydraulic efficiency
  - Mechanical efficiency
  - 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  $15^{\circ}$  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,
- Series
  - Parallel. (08 Marks)

- c. A Centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is  $45^\circ$ . The velocity of flow at the outlet is 2.5 m/s. The discharge through the pump is  $0.2 \text{ m}^3/\text{s}$  when the pump is working against a head of 20 m. If the manometric efficiency is 80%, draw the outlet velocity diagram and calculate :
- The diameter of the impeller at the outlet.
  - Width of the impeller at the outlet.

(08 Marks)

**Module-5**

- 9 a. Define the following with respect to centrifugal compressor :
- Power input factor
  - Pressure coefficient
  - compressor efficiency.
- (06 Marks)
- b. Explain the following with appropriate sketches :
- Surging.
  - 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  $75^\circ$ . Assume axial inlet and consider the inlet total temperature as 300 K, inlet total pressure as 1 bar. Determine :
- Power required to drive the compressor
  - Ideal head developed
  - Work done
  - Total exit pressure

(08 Marks)

**OR**

- 10 a. Explain the following methods of compounding of steam turbines :
- Velocity compounding
  - 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  $18^\circ$ . 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  $3^\circ$  less than the inlet angle. Steam flow rate is 5 kg/s. Draw the velocity triangles and find :
- Blade angles
  - Axial thrust on bearing
  - Power developed
  - Blade efficiency.

(10 Marks)

\*\*\*\*\*