

T.E. (SEM V) Prod / Thermal Engg.

18/12/15

CBGS

QP Code : 5758

(3 Hours)

[ Total Marks : 80

- N. B. : (1) Question No. 1 is compulsory.  
 (2) Attempt any **three** questions out of remaining five questions.  
 (3) Assume suitable data wherever required.  
 (4) Use of steam tables, and psychrometric chart is permitted.

1. Write short notes on any four.

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- (i) Valve timing diagram for petrol engine
- (ii) Psychrometric chart and processes
- (iii) Methods to improve efficiency of a gas turbine
- (iv) Wein's law and Kirchoff's law
- (v) Vapour absorption refrigeration system

2. (a) In a open cycle gas turbine plant air enters at 1 bar and 27°C and leaves the compressor at 6.2 bar. The isentropic efficiency of compressor is 88% and that of turbine is 90%. The fuel has a heating value of 44186 kJ/kg and the fuel air ratio is 0.017 ~~kg of fuel/kg of air~~. Calculate the work of turbine and compressor per kg of air compressed and thermal efficiency. Take  $C_p$  for gas as 1.147 kJ/kgK and  $\gamma = 1.333$  10

(b) The flow rates of hot and cold water streams running through parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 W/m<sup>2</sup>K. Calculate area of heat exchanger. 10

3. (a) 28 tons of ice from and at 0°C is produced per day in an ammonia refrigerator. The temperature range in the compressor is from 25°C to -15°C. The vapour is dry and saturated at the end of compression. Actual COP is 62% of the theoretical one. Calculate the power required to drive the compressor. Take latent heat of ice as 335 kJ/kg. Properties of Ammonia are: 10

| Temp °C | H f ( kJ/kg) | H fg (kJ/kg) | Sf (kJ/kgK) |             |
|---------|--------------|--------------|-------------|-------------|
| 25      | 100.04       | 1319.22      | 0.3473      | 59<br>4.488 |
| -15     | -54.56       | 1304.99      | 42.1338     | 5.062       |

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- (b) In a single acting two stage reciprocating compressor compresses 4.5kg/min of air from 1.0132 bar and 15°C through a pressure ratio of 9:1. Compression and expansion follows the law  $pV^{1.3}=C$  for both stages. For perfect intercooling calculate indicated power and cylinder swept volumes. Assume that the clearance volumes of both stages are 5% of their respective swept volumes and the compressor runs at 300rpm. 10
4. (a) The following observations were recorded in a test of one hour duration on a single cylinder oil engine working on four stroke cycle. 12
- |                                   |              |
|-----------------------------------|--------------|
| bore                              | = 300mm      |
| stroke                            | = 450mm      |
| Fuel used                         | = 8.8kg      |
| Calorific value of fuel           | = 41800kJ/kg |
| Speed                             | = 200rpm     |
| Indicated m. e. p.                | = 5.8bar     |
| Brake load                        | = 1860 N     |
| Diameter of brake wheel           | = 1.22m      |
| Quantity of cooling water         | = 650kg      |
| Temperature rise of cooling water | = 22°C       |
- Calculate Mechanical Efficiency and Brake Thermal Efficiency. Also draw heat balance sheet.
- (b) A mixture of dry air and water vapour is at a temperature of 21°C under a total pressure of 760 mm of Hg. The dew point temperature is 15°C. Find 8
- Partial pressure of water vapour
  - Relative humidity
  - Specific humidity
  - Enthalpy of air per kg of dry air
5. (a) A furnace wall consists of 200mm layer of refractory bricks, 6mm layer of steel plate and a 100mm layer of insulating bricks. The maximum temperature of the wall is 1150°C on the furnace side and the minimum temperature is 40°C on the outermost side of the wall. Heat loss from the wall is 400 W/m<sup>2</sup>. It is known that there is a thin layer of air between the layers of refractory bricks and steel plate. Thermal conductivities for the three layers are 1.52, 45 and 0.138 W/mK respectively. Find thickness of air layer and temperature of the outer surface of the steel plate. 10

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- (b) Explain the working of a two stroke petrol engine and enumerate differences between a two stroke and a four stroke cycle engine. 10
6. (a) A six cylinder 4 stroke SI engine having a piston displacement of 700 cm<sup>3</sup> per cylinder developed 78kW at 3200rpm and consumed 27kg/h of petrol. The calorific value of petrol is 44 MJ/kg. Estimate 10
- (i) The volumetric efficiency of the engine if the A:F = 12:1 and intake air is at 0.9 bar and 32°C.
  - (ii) Brake thermal efficiency
  - (iii) Brake torque
- (b) Explain significance of volumetric efficiency and derive an expression for calculating the same for an air compressor. 10
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