PROD/II/Thermal Engg/10/06/15

QP Code : **3301**

(3 Hours) [**Total Marks : 80**

N. B. : (1) Question no.1 is **compulsory**.
(2) Attempt any **four** questions out of the 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. 20
   (i) Battery ignition system
   (ii) Basic psychrometric processes
   (iii) Methods to improve efficiency of a gas turbine
   (iv) Advantages of multistage compression
   (v) Stefan Boltzman's law and Kirchoff's law
   (vi) Ideal properties of Refrigerant

2. (a) The air enters the compressor of an open cycle gas turbine plant at a pressure of 1bar and temperature of 20°C. The pressure of the air after compression is 4bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air fuel ratio is 90:1. If the flow of air is 3kg/s find Power developed and Thermal efficiency. Take calorific value of fuel as 41800kJ/kg and Cp = 1kJ/kgK andy= 1.4 10
   (b) A 150mm steam pipe has inside diameter of 120mm and outside diameter of 160mm. it is insulated at the outside with asbestos. The steam temperature is 150°c and the air temperature is 20°C. h (steam side)=100 W/m^{2}K and h(air side)=30W/m^{2}K, k(asbestos)=0.8W/mK and k(steel)=42W/mK. How thick should the asbestos be provided in order to limit the heat losses to 2.1kW/m^2 10

3. (a) A refrigerating plant works between temperature limits of -5°C and 25°C using ammonia as the refrigerant. The refrigerant enters the compressor with a dryness fraction of 0.62. The machine has a relative efficiency of 55%, calculate the amount of ice formed in 24hrs from water at 15°C to ice at 0°c. 6.4kg of ammonia per minute is circulated through the system. Take latent heat of ice as 335kJ/kg. Properties of Ammonia are: 10

Temp °c	H f (kJ/kg)	H fg (kJ/kg)	Sf (kJ/kgK)
25	298.9	1167.1	1.124
-5	158.2	1280.8	0.630

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(b) A single stage double acting reciprocating air compressor delivers air at 7 bar. The pressure and temperature at the end of suction stroke are 1bar and 27°C. It delivers 2m^3 /min of free air. When running at 300rpm. The clearance volume is 5% of the stroke volume. The pressure and temperature of ambient air are 1.03bar and 20°C. Index of compression and expansion are 1.3 and 1.35 respectively. Find volumetric efficiency and IP of the compressor and BP if the mechanical efficiency is 80%. Also find diameter and stroke of the cylinder if both are equal. 10

4. (a) Calculate compression ratio and bsfc for a four stroke four cylinder petrol engine, supplied with 15kg of air/kg of fuel. Air standard efficiency is 52%, relative efficiency is 69%, mechanical efficiency is 84%, stroke/bore=1.25, suction pressure 1bar, suction temp 40°C, speed 2500rpm, brake power 75kW, calorific value of fuel 42000kJ/kg. Take R= 0.287kJ/KgK. 10

(b) A mixture of dry air and water vapour is at a temperature of 21°C under a total pressure of 736mm of Hg. The dew point temperature is 15°C. Find 10

(i) Partial pressure of water vapour
(ii) Relative humidity
(iii) Specific humidity
(iv) Enthalpy of air per kg of dry air

5. (a) 500kg of sulphuric acid is cooled per hour from 70°C to 30°C in a counter flow double pipe heat exchanger with the use of 400kg of water per hour available at 20°C. Using the following data find area of heat exchanger required. Specific heat of sulphuric acid is 3.36 kJ/kgK. Convective heat transfer coefficient of water side is 500W/m^{2}K and that of sulphuric acid side is 400 W/m2K. Neglect the resistance of the tube and assume there is no loss of heat in the system. 10

(b) Explain vapour absorption refrigeration cycle. 10

6. (a) From the data given below draw a heat balance sheet for a two stroke diesel engine running for 20 min. 12

RPM= 350
Mep = 300kN/m2
Net brake load= 650N

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Fuel consumption = 1.5kg
Cooling water= 160kg
Air used per kg of fuel = 30kg
Room temp = 20°C
Exhaust temp= 300°C
Cylinder bore = 20cm
Cylinder stroke = 1m
Calorific value of fuel= 44000kJ/kg
Steam formed per kg of fuel = 1.35kg
Pressure of steam in exhaust= 50 kPa
Specific heat of steam= 2.1kJ/kgK
Specific heat of dry gases = 1kJ/kgK

(b) Explain significance of volumetric efficiency and derive an expression for calculating the same for an air compressor. **8**
