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**. 20
   (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 1bar 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 44186kJ/kg and the fuel air ratio is 0.017kJ/kg of air. Calculate the work of turbine and compressor per kg of air compressed and thermal efficiency. Take Cp 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 0.2kg/s and 0.5kg/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^2K. 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 335kJ/kg. Properties of Ammonia are: 10

Temp °C	H f (kJ/kg)	H fg (kJ/kg)	Sf (kJ/kgK)	Sg
25	100.04	1319.22	0.3473	4.488
-15	-54.56	1304.99	+2.1338	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
Indicafed 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

(i) Partial pressure of water vapour
(ii) Relative humidity
(iii) Specific humidity
(iv) 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^2. 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^3 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
