CBCS SCHEME

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15ME43

Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer FIVE full questions, choosing one full question from each module.***
2. ***Use of steam table/Mollier chart/Psychrometric chart is permitted.***

Module-1

1 a. Derive an expression of Air-standard efficiency of otto cycle with neat sketch of P-V and T-S diagrams. **(06 Marks)**

b. With a neat sketch, explain the working of Ram jet. **(05 Marks)**

c. Calculate the percentage loss in the ideal efficiency of a diesel engine with compression ratio 14 if the fuel cut-off is delayed from 5% to 8%. **(05 Marks)**

OR

2 a. With a neat block diagram and T-S diagram, explain how 'regeneration' increases thermal efficiency of gas turbine plant. **(06 Marks)**

b. Define Air-standard efficiency. **(02 Marks)**

c. A Gas turbine unit has a pressure ratio 6 : 1 and maximum cycle temperature of 610°C. The isentropic efficiencies of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output when the air enters the compressor at 15°C at the rate of 16 kg/s. Take $C_P = 1.005$ KJ/kgK and $\gamma = 1.4$ for compression and $C_P = 1.11$ kJ/kgK and $\gamma = 1.333$ for expansion processes. **(08 Marks)**

Module-2

3 a. With the help of corresponding flow and T-S diagrams explain briefly the working of a practicle regenerative Rankine cycle with one open feed water heater. Derive also an expression for its thermal efficiency. **(08 Marks)**

b. A simple Rankine cycle works between the boiler pressure of 3 MPa and condenser pressure of 4 KPa. The steam is dry saturated before the throttling in the turbine. Determine (i) Rankine cycle efficiency (ii) Work ratio (iii) Specific steam consumption. **(08 Marks)**

OR

4 a. Discuss the effect of, (i) Boiler pressure (ii) Condenser pressure (iii) Super heat on the performance of a Rankine cycle. **(08 Marks)**

b. A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser at 0.1 bar. Draw h-s diagram. Find (i) Quality of steam at turbine exhaust (ii) Cycle efficiency (iii) Steam rate in $\frac{kg}{hr.KW}$ **(08 Marks)**

Module-3

5 a. Explain the following: (i) Stoichiometric air (ii) Enthalpy of formation. **(04 Marks)**

b. Explain the method of finding friction power using Morse test. **(04 Marks)**

c. A Solid fuel contains by weight, carbon 71%, hydrogen 4%, oxygen 9%, Sulphur 3%, Nitrogen 1% and the remainder is ash. Determine the minimum quantity of air required for complete combustion of 1 kg of fuel. If the actual air supplied is 1.3 times the minimum required for complete combustion, estimate the percentage gravimetric composition of dry gases. **(08 Marks)**

OR

6 a. Classify the IC engines. **(04 Marks)**

b. Define : (i) BSFC (ii) Indicated thermal efficiency. **(04 Marks)**

c. In a trial of a single cylinder oil engine working on dual cycle, the following observations were made:
Oil consumption = 10.2 kg/h ; Calorific value of fuel = 43890 kJ/kg
Air consumption = 3.8 kg/min; Speed = 1900 rpm
Torque on the brake drum = 186 N-m; Quantity of cooling water used = 15.5 kg/min
Temperature rise = 36°C; Exhaust gas temperature = 410°C
Room temperature = 20°C; 'C_P' of exhaust gases = 1.17 kJ/kgK
Calculate Brake thermal efficiency and draw heat balance sheet on minute basis. **(08 Marks)**

Module-4

7 a. With a neat sketch, explain the working of Bell – Coleman air refrigeration cycle. **(06 Marks)**

b. Show the following processes on psychometric chart: (i) Sensible heating and cooling (ii) Cooling and dehumidification **(04 Marks)**

c. In a simple vapour compression cycle, following are the properties of the refrigerant R-12 at various points;
Compressor inlet : $h_2 = 183.2$ KJ/kg; $V_2 = 0.0767$ m^3/kg
Compressor discharge : $h_3 = 222.6$ KJ/kg; $V_3 = 0.0164$ m^3/kg
Compressor exit : $h_4 = 84.9$ KJ/kg; $V_4 = 0.00083$ m^3/kg
The piston displacement volume for compressor is 1.5 litres per stroke and its volumetric efficiency is 80%. The speed of the compressor is 1600 rpm. Find (i) Power rating of the compressor (KW) (ii) Refrigerating effect (KW) **(06 Marks)**

OR

8 a. Define (i) Dry bulb temperature (ii) Wet bulb temperature (iii) Dew point temperature (iv) Relative humidity. **(04 Marks)**

b. State the properties of good refrigerant. **(04 Marks)**

c. An air conditioning system is designed under the following conditions:
Outdoor conditions = 30°C DBT and 75% RH
Required indoor conditions = 22°C DBT and 70% RH
Amount of free air circulated = 3 m^3/sec
Coil dew point temperature = 14°C
The required condition is achieved first by cooling and dehumidification and then by heating. Calculate (i) the capacity of the cooling coil in tones.
(ii) the capacity of the heating coil in KW.
(iii) the amount of water vapour removed in kg/s. **(08 Marks)**

Module-5

9 a. What are the advantages of multistage compression? **(04 Marks)**

b. What do you mean by a supersaturated flow? Explain with the help of h-s diagram. **(06 Marks)**

c. A single stage double-acting air compressor is required to deliver 14 m^3 of air per minute at 1.013 bar and 15°C. The delivery pressure is 7 bar and the speed 300 rpm. Take the clearance volume as 5% of the swept volume with the compression and expansion index n = 1.3, calculate (i) Swept volume of cylinder (ii) Indicated power. **(06 Marks)**

OR

10 a. Derive an expression for the condition for minimum work input required for two stage compressor with perfect intercooling. **(08 Marks)**

b. A multistage compressor is to be designed to elevate the pressure from 1 bar to 120 bar, such that the stage pressure ratio will not exceed 4. Determine (i) Number of stages (ii) Minimum power required (iii) Intermediate pressures (iv) Exact pressure ratio. It is required to compress 15 m^3/min of free air. Take n = 1.2 **(08 Marks)**

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