CBCS SCHEME

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15ME43

Fourth Semester B.E. Degree Examination, June/July 2019
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermodynamic Data handbook / Steam tables / Mollier chart are permitted.***

Module-1

1 a. What is an Air Standard efficiency? Derive an expression for Air Standard efficiency of a Diesel cycle. **(08 Marks)**

b. An engine of 250mm bore and 375mm stroke works on Otto cycle. The clearance volume is $0.00263m^3$. The initial pressure and temperature are 1 bar and 50^0C. If the maximum pressure is limited to 25 bar, find the following i) The air standard efficiency of cycle ii) The mean effective pressure for the cycle. **(08 Marks)**

OR

2 a. Discuss briefly any two methods employed for improvement of thermal efficiency of open cycle gas turbine plant. **(06 Marks)**

b. State the working difference between Turbo Jet and Turbo – prop engines. **(04 Marks)**

c. A gas turbine has a pressure ratio of 6 and a maximum cycle temperature of 600^0C. The Isentropic efficiencies of compressor and turbine are 0.82 and 0.85 respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 15^0C at the rate of 15 kgs. Take $C_p = 1.005$ kJ/kg K and $\gamma = 1.4$ for compression process and $C_p = 1.11$ kJ.kg K and $\gamma = 1.333$ for the expansion process. **(06 Marks)**

Module-2

3 a. Describe the different processes of Rankine cycle. Derive also an expression for its efficiency. **(08 Marks)**

b. A simple Rankine cycle works between 28 bar and 0.06 bar, the initial condition of steam is being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption. **(08 Marks)**

OR

4 a. Explain with the help of neat T – S diagram and block diagram a practical regenerative cycle and also derive and expression for its thermal efficiency with one open feed water heater. **(08 Marks)**

b. A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410^0C. If the steam is reheated at 5.5 bar to a temperature of 395^0C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction at the exit of turbine and thermal efficiency of the cycle? **(08 Marks)**

Module-3

5 a. Define the following : i) Stoichiometric air fuel Ratio ii) Excess air iii) Enthalpy of Reaction iv) Enthalpy of Formation. **(08 Marks)**

b. The following is the volumetric analysis of the dry exhaust from an I.C. Engine $CO_2 = 8.9\%$, $CO = 8.2\%$, $H_2 = 4.3\%$, $CH_4 = 0.5\%$, $N_2 = 78.1\%$. If the Fuel used is Octane C_8H_{18}. Determine the air Fuel Ratio on mass basis. **(08 Marks)**

OR

6 a. Explain the phenomenon of knocking in SI engine. What are the different factors which influence the knocking? **(08 Marks)**

b. During a 60 minute trail of a single cylinder four stroke engine the following observations were recorded. Bore = 0.3m , Stroke = 0.45m , Fuel consumption = 11.4kg , Calorific value = 42000 kJ/kg , IMEP = 6 bar , Net load on brake = 1500N , Speed = 300 rpm , Brake drum diameter = 1.8m , Rope diameter = 20mm , Quantity of Jacket cooling water = 600kg , Rise in temperature of Jacket cooling water = 55^0C, Quantity of air = 250 kg Exhaust gas temperature = 420^0C , Ambient temperature = 20^0C , C_p for gases = 1kJ/kg K. Find IP, BP, mechanical efficiency and draw heat balance sheet on minute basis. **(08 Marks)**

Module-4

7 a. Discuss the effect of following on the performance of a vapour compression system : i) Effect on suction pressure ii) Effect of super heating iii) Effect of subcooling. **(08 Marks)**

b. A refrigeration system of 10.5 tonnes capacity at an evaporator temperature of -12^0C and a condenser temperature of 27^0C is needed in a food storage locker. The Refrigerant Ammonia is sub cooled by 6^0C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator coil. Find C.O.P and power required in KW. **(08 Marks)**

OR

8 a. Define Specific humidity and derive an expression for the specific humidity. **(08 Marks)**

b. It is required to design an air conditioning plant for a small office for following conditions : Outdoor condition = 14^0C DBT and 10^0C WBT , Required conditions = 20^0C DBT and 60% RH ; Amount of air circulated = 0.3m^3/min/person , Seating capacity = 60. The required condition is achieved first by heating and then by adiabatic humidifying. Determine i) Heating capacity of coil in KW and its surface temperature if the by pass factor of coil is 0.4 ii) Capacity of the humidifier. **(08 Marks)**

Module-5

9 a. Define volumetric efficiency of an air compressor and derive an expression for volumetric efficiency. **(08 Marks)**

b. An air compressor takes in air at 1 bar and 20^0C and compresses it according to law $PV^{1.2}$ = constant. It is then delivered to a receiver at a constant pressure of 10 bar. Determine i) Temperature at the end of compression ii) Work done iii) Heat transferred during the compression per kg of air. **(08 Marks)**

OR

10 a. What is the effect of friction on the flow through a steam nozzle? Explain with the help of h – s diagram. **(08 Marks)**

b. Steam is expanded in a set of nozzles from 10 bar 200^{0}C to 5 bar. Neglecting the initial velocity, find the minimum area of the nozzle required to allow a flow of 3kg/s under the given conditions. Assume that expansion of steam to be isentropic. **(08 Marks)**

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