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10ME/AU43

Fourth Semester B.E. Degree Examination, July/August 2021
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of thermodynamic data hand book is permitted.***

1 a. Explain the following with reference to combustion process:
(i) Stoichiometric air
(ii) Adiabatic flame temperature
(iii) Enthalpy of combustion. **(06 Marks)**

b. Find the stoichiometric air for the combustion of gaseous propane (C_3H_8) on mass and molar basis. **(04 Marks)**

c. The products of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat apparatus:
$CO_2 = 8\%$, $CO = 0.9\%$, $O_2 = 8.8\%$, $N_2 = 82.3\%$
Determine (i) The composition of the fuel (ii) The air fuel ratio
(iii) The percentage excess air used. **(10 Marks)**

2 a. Sketch neatly P-V and T-S diagram of the air standard diesel cycle and derive an expression for efficiency of the cycle. **(08 Marks)**

b. An engine working on the otto cycle is supplied with air at 100 KPa, 35°C. The compression ratio is 8. Heat supplied is 2100 KJ/kg.
Calculate the maximum pressure and temperature of the cycle, the cycle efficiency, and the mean effective pressure. **(12 Marks)**

3 a. Explain clearly how the friction power of a multi-cylinder IC-engine can be determined through Morse test. **(08 Marks)**

b. In a test on a three cylinder Four stroke internal combustion engine with 22 cm bore and 26 cm stroke the following were the observations during a trial period of one hour ;
Fuel consumption = 8.0 kg, Calorific value = 45000 KJ/kg,
Total revolutions of Crank shaft = 12000, Mean effective pressure = 6 bar,
Net load on brake = 1.5 KN, Brake drum diameter = 1.8 m,
Rope diameter = 3 cm, Mass of cooling water = 550 kg,
Rise in temperature of cooling water = 28°C, Air consumed = 300 kg
Ambient temperature = 30°C, Exhaust gas temperature = 310°C,
Specific heat of exhaust gas = 1.1 KJ/kg-K.
Calculate : (i) Indicated and Brake power
(ii) Mechanical efficiency
(iii) Indicated thermal efficiency
Also draw a heat balance sheet. **(12 Marks)**

4 a. Sketch the flow and a corresponding T-S diagram for a steam power plant working on regenerative cycle with one open feed water heater. Write the energy balance for the feed water heater. Describe its operation briefly. **(10 Marks)**

b. Steam enters the turbine of a steam power plants operating on Rankine cycle, at 10 bar, 300°C. The condenser pressure is 0.1 bar. Steam leaving the turbine is 90 % dry. Calculate the adiabatic efficiency of the turbine and also the cycle efficiency, neglecting pump work. **(10 Marks)**

5 a. Derive an expression for minimum work required by two-stage air compressor. With perfect intercooling between the stages. **(10 Marks)**

b. A two stage air compressor with perfect intercooling takes in air at 1 bar and 27°C. The law of compression in both stages is $PV^{1.3}$ = constant. The compressed air is delivered at 9 bar. Calculate for unit mass flow rate of air the minimum work required and heat rejected in intercooler. What is the amount of work required if compression is carried in single stage? **(10 Marks)**

6 a. Explain the effects of : (i) Intercooling (ii) Reheating on Brayton cycle. **(08 Marks)**

b. A simple gas turbine plant operating on Brayton cycle has air entering the compressor at 100 KPa and 27°C. The pressure ratio = 9 and maximum cycle temperature is 727°C. What will be the percentage change in cycle efficiency and network output, if the expansion in turbine is divided in to 2 stages, each of pressure ratio 3 with intermediate reheating to 727°C. Assume compression and expansion are ideal isentropic. **(12 Marks)**

7 a. Write a brief note on properties of refrigerants. **(04 Marks)**

b. With a neat sketch, explain the working of a Bell-Coleman cycle. **(06 Marks)**

c. The temperature limits of vapour compression refrigeration cycle is −7°C and 27°C. If the refrigerant is dry and saturated at the end of compression and there is no subcooling. Find COP of the cycle. Also calculate the capacity of refrigerator if the fluid flow rate is 5 kg/min.

The properties of refrigerant are as follows :

Temperature	Sensible heat (KJ/kg)	Latent heat (KJ/kg)	Entropy of liquid (KJ/kg°C)	Entropy of vapour (KJ/kg°C)
27°C	117.23	1172.3	0.427	4.338
−7°C	−29.3	1297.9	−0.109	4.748

(10 Marks)

8 a. Define the following terms as applied to an air-water vapour mixture:

(i) Relative humidity
(ii) Dew point temperature.
(iii) Wet bulb temperature. **(06 Marks)**

b. Show that the humidity ratio (specific humidity) w of atmospheric air is given by, w = 0.622 Pv/Pa where Pv and Pa are the partial pressures of water vapour and air respectively. **(04 Marks)**

c. It is required to design an air conditioning plant for a office room with the following conditions : Outdoor conditions 14°C DBT and 10°C WBT ; Required conditions 20°C DBT and 60% RH ; Amount of air circulation 0.3 m^3/min/person seating capacity of office 60. The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following :

(i) Heating capacity coil in kW and surface temperature required if the bypass factor of the coil is 0.4.
(ii) The capacity of the humidifier. **(10 Marks)**

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