CBCS SCHEME

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18MR43

Fourth Semester B.E. Degree Examination, June/July 2024
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Derive an expression for the air standard efficiency of a diesel cycle. **(08 Marks)**

b. Minimum pressure and temperature in an otto cycle are 100KPa and 27°C. The amount of heat added to air per cycle is 1500kJ/kg.
Determine the pressure and temperature at all the points of otto cycle
i) Specific work and thermal efficiency
ii) Mean effective pressure
iii) Take for air $e_v = 0.72$kJ/kg K : $\gamma = 1.4$. **(12 Marks)**

OR

2 a. With a neat sketch, explain turbojet and ramjet propulsions. **(10 Marks)**

b. A gas turbine plant draws air at 1.013 bar and 10°C has a pressure ratio of 5.6. The maximum temperature in the cycle is limited to 750°C. The compression is conducted in an air cooled rotary conducted in an isentropic efficiency of 82% and takes place in a turbine with an isentropic efficiency 85%. A heat exchanger with an efficiency of 70% is fitted between the compressor out let and combustion chamber for an air flow of 40kg/s. Find :
i) Overall efficiency
ii) Turbine output
iii) Air fuel ratio if $e_v = 42.25$MJ/kg. **(10 Marks)**

Module-2

3 a. What is regenerative cycle? With the help of neat diagram, explain the working of regenerative Rankine cycle and derive the efficiency of the cycle. **(10 Marks)**

b. In a Rankine cycle, the steam at inlet to the turbine is saturated at pressure of 35 bar and the exhaust pressure is 0.2bar. Calculate :
i) Pump work
ii) The turbine work
iii) Rankine efficiency
iv) Condenser heat flow
v) Dryness fraction at the end of expansion.
Assume mass flow rate of steam to be 9.5kg/s. **(10 Marks)**

OR

4 a. With PV and T – S diagram discuss the effect of :
i) Boiler pressure
ii) Condenser pressure. **(08 Marks)**

b. A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410°C the steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle. If the steam is reheated to 5.5bar to a temperature of 400°C and then expanded isentropically to a pressure 0.08bar. What will be the dryness fraction and thermal efficiency of the cycle? **(12 Marks)**

Module-3

5 a. With neat sketch, explain the analysis of exhaust gases by ORSAT apparatus. **(08 Marks)**

b. Butane is burnt with air and volumetric analysis of combustion of products on dry basis yields following constituents CO_2 is 7.8%, CO is 1.1%, O_2 is 8.2% and N_2 is 82.9%. Determine :
i) Theoretical and excess air
ii) Composition of fuel. **(12 Marks)**

OR

6 a. Explain the following with related to combustion of fuel.
i) Theoretical air
ii) Excess air
iii) Enthalpy of combustion
iv) Enthalpy of formation
v) Adiabatic flame temperature. **(10 Marks)**

b. The product of combustion of an unknown hydrocarbon $C_x H_y$ have following composition as measured by an orsat apparatus CO_2 is 8%, CO is 9%, O_2 is 8.8% and N_2 is 82.3% determine the composition of fuel, A/F ratio and % of excess air. **(10 Marks)**

Module-4

7 a. Explain the following :
i) Morse test for multi-cylinder engine
ii) Williams line method
iii) Motoring method. **(12 Marks)**

b. The following readings were taken during the test of a single cylinder 4-stroke oil engine cylinder diameter = 250mm, stroke length = 400mm, Gross m_{ep} is 7 bar, pumping M_{ep} is 0.5bar, Engine speed = 250rpm, Net load on brake = 1080N effective dia of brake is 1.5m, fuel used per hour is 10kg, calorific value = 44300kJ/kg. Calculate :
i) Indicate power
ii) Brake power
iii) Mechanical efficiency
iv) Indirected thermal efficiency. **(08 Marks)**

OR

8 a. With the help of P - θ diagram explain the stages of combustion in CI Engine. **(08 Marks)**

b. From the data given below calculate the indicated power, brake power and draw the heat balance sheet for a two stroke diesel engine run for 20 minutes at full load. speed = 350rpm M_{ep} = 3.10bar, Net brake load = 640N, fuel consumption = 1.52kg, mass of cooling water is 162kg, water inlet temperature = 30°C, water outlet temperature 55°C, Air used per kg of fuel 32kg, room temperature 25°C, exhaust gas temperature = 305°C, cylinder bore 200mm, Cylinder stroke = 280mm, Brake diameters is 1m, calorific value = 43900kJ/kg, steam formed per kg of fuel is 1.4kg; ; $C_{P_s} = 2.09 kJ/kg$; $C_{P_g} = 1 kJ/kg\,k$. **(12 Marks)**

Module-5

9 a. With schematic diagram explain the working of vapour compression refrigeration system. **(06 Marks)**

b. What are the desirable properties of referegents? Explain briefly. **(06 Marks)**

c. A 10 ton ammonia ice plant operates between an evaporator temperature of –15°C and condenser temperature of 35°C. The ammonia enters the compressor as dry saturated vapour. Assuming isentropic compression determine :

i) Mass flow rate of NH_3

ii) COP of plant

iii) Power input in KW.

T	h_f (kJ/kg)	h_g (kJ/kg)	S_f (kJ/k)	S_g (kJ/k)
–15	112.17	1424.9	0.4564	5.542
35	346.89	1470.3	1.28	4.9264

Take Enthalpy of fusion of ice = 334 kJ/kg ; $C_{p_w} = 4.187 kJ/kg\,k$ $C_{p_{ae}} = 2.1 kJ/kg\,k$ C_p for superheated NH_3 = 2.82kJ/kg k. **(08 Marks)**

OR

10 a. With a neat sketch explain winter air conditioning system. **(10 Marks)**

b. Atmospheric air at 101.325KPa has 30°C DBT and 15°C DPT. Without using the psycprometric chart using property values from the tables calculate :

i) Partial pressure of air and water vapour

ii) Specific humidity

iii) Relative humidity

iv) Vapour density

v) Enthalpy of moist air. **(10 Marks)**

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