

End-Term Examination
(CBCS)(SUBJECTIVE TYPE)(Offline)
Course Name :< B.Tech. (MAE/DMAM)>, Semester:<3rd>
(Nov-Dec, 2022)

Subject Code: BMA205 Subject: Thermal Engineering - I
Time : 3 Hours Maximum Marks :60
Note: Q. 1 Is compulsory. Attempt one question each from the Units I, II, III & IV.

(2.5*8=20)

- Q1
- (a) Apply steady flow energy equation to a nozzle to get the expression for the exit velocity.
 - (b) Give the statement of Clausius inequality and write its mathematical expression.
 - (c) Define entropy and write the expressions for change in entropy during a constant volume process taking place in a closed system.
 - (d) Define irreversibility and write the Gouy-stodola equation.
 - (e) Draw p-v diagram for a Diesel cycle and define compression ratio and cut off ratio.
 - (f) Write the expression for the entropy of superheated steam in terms of specific heat of saturated water ($C_{p,w}$), saturation temperature (T_s), latent heat (h_{fg}), specific heat of superheated steam ($C_{p,sup}$) and superheat temperature (T_{sup}).
 - (g) Draw the component layout of a steam power plant working on regenerative cycle with two direct or mixing type feed heaters and the cycle on T-s plane.
 - (h) Define Adiabatic Flame Temperature. How is it calculated?

- Q2 Prove that internal energy is a point function. (10)
- Q3 State and prove Carnot first theorem. (10)

UNIT-II

- Q4 Air expands through a turbine from 500 kPa and 520°C to 100 kPa and 300°C. During expansion 10 kJ/kg of heat is lost to the surroundings which are at 98 kPa and 20°C. Neglecting the changes in kinetic and potential energies, determine per kg of air (i) the decrease in availability, and (ii) the irreversibility. For air take $C_p = 1.005$ kJ/kg-K and $R = 0.287$ kJ/kg-K. (10)
- Q5 Derive the two T-ds equations. (10)

UNIT-III

- Q6 Draw the Brayton cycle on p-v and T-s planes and derive the expression for thermal efficiency in terms of pressure ratio of the cycle and the specific heat ratio of the working substance. (10)
- Q7 Draw the air standard dual cycle on p-v and T-s planes and set up the expression for thermal efficiency in terms of compression ratio, explosion ratio, cut off ratio and specific heat ratio. (10)

UNIT-IV

- Q8 In a Rankine cycle-based steam power plant, steam at 50 bar and 400°C enters the steam turbine and expands isentropically to a condenser pressure of 0.1 bar. Calculate thermal efficiency of the plant. Use the following properties of steam: (10)

For superheated steam:

Absolute pressure, p (bar)	Temperature, t_s (°C)	Specific enthalpy, h (kJ/kg)	Specific entropy, s (kJ/kg K)	Specific volume, v (m ³ /kg)
50	400	3196.7	6.6483	0.0578370

For saturated water and steam:

Pressure (bar)	Specific volume (m ³ /kg)	Specific enthalpy (kJ/kg)			Specific entropy (kJ/kg K)		
	v_f	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
0.1	0.0010102	191.8	2392.1	2583.9	0.6492	7.4996	8.1488

Q9 Ethyl alcohol (C_2H_6O) burns with chemically correct quantity of air. Calculate the air-fuel ratio on a mass basis. (10)