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End of the Term Evaluation (April 2019)

School: School of Engineering. **Program:** B-Tech- Mechatronics

Course: Fundamentals of Thermodynamics **Course Code:** MTE-202

Semester: IV **Max Marks:** 35 **Duration**: 120 (mins)

Note:1) Answers should be written in Answer Sheet Provided.
2) Figures to the right indicate full marks.
3) Neat diagrams must be drawn wherever necessary.
4) Use of only electronic pocket calculator is allowed.
5) Assume suitable data, if necessary.
6) Q.1A& Q1B is compulsory Solve Any 4 Questions from Q2 to Q7

Q1A. Choose the correct Alternative:

1. For a reversible adiabatic process, the change in entropy is
   (a) zero (b) minimum (c) maximum (d) infinite (e) unity.
2. The change of entropy, when heat is absorbed by the gas is
   (a) positive (b) negative (c) positive or negative..
3. Which of the following is correct?
   (a) Specific volume of water decreases on freezing (b) Boiling point of water decreases with increasing pressure (c) Specific volume of CO_2 increases on freezing (d) Freezing temperature of water decreases with increasing pressure.
4. The latent heat of vapourisation at critical point is
   (a) less than zero (b) greater than zero (c) equal to zero (d) none of the above.
5. With the increase in pressure
   (a) boiling point of water increases and enthalpy of evaporation increases
   (b) boiling point of water increases and enthalpy of evaporation decreases
   (c) boiling point of water decreases and enthalpy of evaporation increases.
6. Dryness fraction of steam is defined as
   (a) mass of water vapour in suspension/(mass of water vapour in suspension + mass of dry steam)
   (b) mass of dry steam/mass of water vapour in suspension
   (c) mass of dry steam/(mass of dry steam + mass of water vapour in suspension)
   (d) mass of water vapour in suspension/mass of dry steam.
7. The specific volume of water when heated at 0°C
   (a) first increases and then decreases (b) first decreases and then increases
   (c) increases steadily (d) decreases steadily.
8. Heat of superheated steam is given by
   (a) $h_{sup} = h_f + h_{fg} + cp_s \log_e T_{sup} / T_s$ (b) $h_{sup} = h_f + x_{hfg}$
   (c) $h_{sup} = h_f + h_{fg}$ (d) $h_{sup} = h_f + x_{hfg} + cp_s \log_e T_s/273$.

9. In throttling process

(a) $h_1^2 = h_2$ (b) $h_1 = h_2$ (c) $h_1 = h_2 + h_{fg}/T_s$ (d) $h_2 = h_1 + h_{fg}/T_s$

10. With the increase in pressure

(a) boiling point of water increases and enthalpy of evaporation increases

(b) boiling point of water increases and enthalpy of evaporation decreases

(c) boiling point of water decreases and enthalpy of evaporation increases.

11. Rankine cycle efficiency of a good steam power plant may be in the range of

(a) 15 to 20% (b) 35 to 45% (c) 70 to 80% (d) 90 to 95%

12. Rankine cycle comprises of

(a) two isentropic processes and two constant volume processes

(b) two isentropic processes and two constant pressure processes

(c) two isothermal processes and two constant pressure processes

13. Regenerative heating i.e., bleeding steam to reheat feed water to boiler

(a) decreases thermal efficiency of the cycle

(b) increases thermal efficiency of the cycle

(c) does not affect thermal efficiency of the cycle

(d) may increase or decrease thermal efficiency of the cycle depending upon the point of extraction of steam.

14. The air standard Otto cycle comprises

(a) two constant pressure processes and two constant volume processes

(b) two constant pressure and two constant entropy processes

(c) two constant volume processes and two constant entropy processes

(d) none of the above

15. The thermal efficiency of theoretical Otto cycle

(a) increases with increase in compression ratio

(b) increases with increase in isentropic index γ

(c) does not depend upon the pressure ratio

(d) follows all the above.

16. For same compression ratio

(a) thermal efficiency of Otto cycle is greater than that of Diesel cycle

(b) thermal efficiency of Otto cycle is less than that of Diesel cycle

(c) thermal efficiency of Otto cycle is same as that for Diesel cycle

(d) thermal efficiency of Otto cycle cannot be predicted.

17. In air standard Diesel cycle, at fixed compression ratio and fixed value of adiabatic index (γ)

(a) thermal efficiency increases with increase in heat addition cut-off ratio

(b) thermal efficiency decreases with increase in heat addition cut-off ratio

(c) thermal efficiency remains same with increase in heat addition cut-off ratio

(d) none of the above.

18. In a two stage gas turbine plant, with intercooling and reheating

(a) both work ratio and thermal efficiency improve

(b) work ratio improves but thermal efficiency decreases

(c) thermal efficiency improves but work ratio decreases

(d) both work ratio and thermal efficiency decrease.

19. The Fourier's law of heat transfer by conduction is expressed as

(a) $Q = kA^2dt/dx$ (b) $Q = kA\,dt/dx$

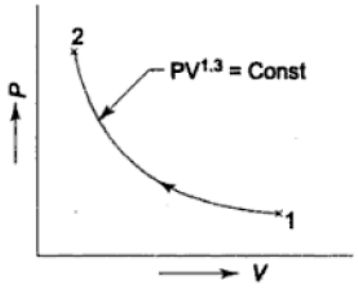
(c) $Q = k^2Adx/dt$ (d) $Q = k^3A\,dx/dt$

20. The quantity of heat radiation is dependent on
(a) area of the body only (b) shape of the body only
(c) temperature of the body only (d) on all (a), (b) and (c). [10]

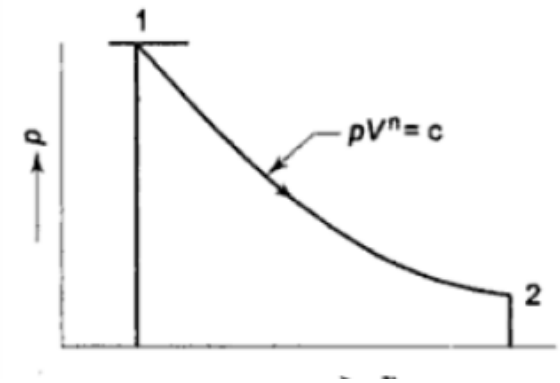
Q1B. Answer Any-2-Only of the following questions: Draw neat diagrams wherever necessary.

i. Explain briefly the working of a Separating and Throttling calorimeter.
ii. Explain briefly the working of a steam plant on a Rankine Reheat Cycle.
iii. Explain briefly the working of a constant volume cycle. Which engines use these cycles?
iv. Sketch a schematic of a Turbo-Jet Engine with the various components and show the ideal Turbo-Jet Cycle on a T-S diagram
v. Explain heat Transfer by Conduction, Convection and Radiation giving equations. [5]

Q2. A fluid undergoes a reversible adiabatic compression from 0.5 MPa, 0.2 m^3 to 0.05 m^3 According to the law, $pv^{1.3}$= Constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process. [5]



Q3. A 280 mm diameter cylinder fitted with a frictionless leak proof piston contains 0.02 kg of steam at a pressure of 0.6 MPa and a temperature of 200°C. As the piston moves slowly outwards through a distance of 305 mm, the steam undergoes a fully-resisted expansion during which the steam pressure p and the steam volume v are related by $p.v^n$ = constant, where n is a constant. The final pressure of the steam is 0.12 MPa. Determine (a) the value of n, (b) the work done by the steam, and (c) the magnitude and sign of heat transfer. [5]



Q4. A steam power station uses the following cycle:
Steam at boiler outlet - 150 bar, 550°C
Reheat at 40 bar to 550°C
Condenser at 0.1 bar.
Using the Mollier chart and assuming ideal processes, find the (a) quality at Turbine Exhaust, (b) Cycle Efficiency, and (c) Steam rate. [5]

Q5. In an air standard Otto cycle the compression ratio is 7, and compression begins at 35°C, 0.1MPa. The maximum temperature of the cycle is 1100°C. Find (a) the temperature and pressure at the cardinal points of the cycle, {b} the heat supplied per kg of air, (c) the work done per kg of air, (d) the cycle efficiency, and (e) the m.e.p. of the cycle. [5]

Q6 In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate (a) the cut-off ratio, (b) the heat supplied per kg of air, (c) the cycle efficiency, and (d) the m.e.p. [5]

Q7 The interior of a refrigerator having inside dimensions of 0.5 m × 0.5 m base area and 1 m height, is to be maintained at 6°C. The walls of the refrigerator are constructed of two mild steel sheets 3 mm thick (k = 46.5 W/m°C) with 50 mm of glass wool insulation (k = 0.046 W/m°C) between them. If the average heat transfer coefficients at the inner and outer surfaces are 11.6 W/m^2°C and 14.5 W/m^2°C respectively, Calculate:
(i) The rate at which heat must be removed from the interior to maintain the specified temperature in the kitchen at 25°C, and
(ii) The temperature on the outer surface of the metal sheet. [5]

STEAM TABLES

TABLE III
Superheated Steam at Various Pressures and Temperatures

↓p (bar) (t_s)	t (°C) →	350	375	400	450	500	550	600	700
150 (342.1)	v	0.01145	0.01388	0.01565	0.01845	0.02080	0.02293	0.02491	0.02861
	h	2692.4	2858.4	2975.5	3156.2	3308.6	3448.6	3582.3	3840.1
	s	5.442	5.703	5.881	6.140	6.344	6.520	6.679	6.957

↓p (bar) (t_s)	t (°C) →	200	250	300	350	400	450	500	600
40 (250.4)	v			0.0588	0.0664	0.0734	0.080	0.0864	0.0989
	u			2725.3	2826.7	2919.9	3010.2	3099.5	3279.1
	h			2960.7	3092.5	3213.6	3330.3	3445.3	3674.4
	s			6.362	6.582	6.769	6.936	7.090	7.369

↓p (bar) (t_s)	t (°C) →	200	250	300	350	400	450	500	600
6.0 (158.8)	v	0.352	0.394	0.434	0.474	0.514	0.553	0.592	0.670
	u	2638.9	2720.9	2801.0	2881.2	2962.1	3044.2	3127.6	3299.1
	h	2850.1	2957.2	3061.6	3165.7	3270.3	3376.0	3482.8	3700.9
	s	6.967	7.182	7.372	7.546	7.708	7.859	8.002	8.267

TABLE II
Saturated Water and Steam (Pressure) Tables

Absolute pressure (bar)	*Temp. (°C)*	*Specific enthalpy (kJ/kg)*			*Specific entropy (kJ/kg K)*			*Specific volume (m^3/kg)*	
p	t_s	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g	v_f	v_g
12.0	188.0	798.4	1 984.3	2 782.7	2.216 1	4.303 3	6.519 4	0.001139	0.163
0.10	45.8	191.8	2 392.8	2 584.7	0.649	7.501	8.150	0.001010	14.67
1.2	104.8	439.4	2 244.1	2 683.4	1.360 9	5.937 5	7.298 4	0.001048	1.428
6.0	158.8	670.4	2 085.0	2 755.5	1.930 8	4.826 7	6.757 5	0.001101	0.315