Name:

Enrolment No:

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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2021

Course: Thermodynamics and Phase Behavior **Semester: III**
Program: B.Tech – Petroleum Engineering (Upstream) **Time 03 hrs.**
Course Code: MEPD2007 **Max. Marks: 100**

SECTION A

1. **Each Question will carry 5 Marks**
2. **Instruction: Write the statement / answer(s)** **5 × 4 M= 20 M**

S. No.	Question	CO
Q 1	Discuss a pure substance. Is iced water a pure substance? Why?	CO1
Q2	What is the difference between an ideal and a perfect gas?	CO1
Q3	Write a short note on (i) Mollier chart (ii) Compressibility Factor	CO2
Q4	What is a perpetual motion machine of second kind? Why is it impossible?	CO1
Q5	A refrigerator based on reversed Carnot cycle works between two such temperatures that the ratio between the low and high temperature is 0.8. If a heat pump is operated between the same temperature range, then what would be its COP?	CO3

SECTION B

1. **Each Question will carry 10 Marks**
2. **Instruction: Write short / brief notes** **4 × 10 M= 40 M**

Q6	A reversible change has quasi-static characteristics, but a quasi-static process may not be reversible one, Justify.	CO1
Q7	A mass of gas is compressed in a quasi-static process from 70 kPa, 0.1 m^3 to 0.4 MPa, 0.03 m^3. Assuming that the pressure and volume are related by PV^n =constant, find the work done by the gas system.	CO2
Q8	Derive an expression for the ideal efficiency of an Otto cycle.	CO3
Q9	Wet steam at 165 ˚C and dryness fraction of 0.75 is heated at a constant pressure until it becomes superheated vapour at 300 ˚C. Find the change in specific volume, enthalpy, and entropy.	CO3

Section C

1. **Each Question will carry 20 Marks**
2. **Instruction: Write long answer.** **2 × 20 M= 40 M**

Q10 A flow rate of 0.42 kg/s is maintained in a steam turbine under steady flow conditions as it receives steam with an enthalpy 3240 kJ/kg, velocity 35 m/s and elevation 4 m. The outlet of steam from the turbine has enthalpy of 2450 kJ/kg, velocity 125 m/s, and elevation 1 m. In the entire process the heat lost takes place at the rate of 0.25 kJ/s. Determine the power output of the turbine in kW? **CO4**

Q11 Define entropy. What do you understand by entropy principle? What are the causes of entropy increases? **CO2**

OR

With the help of pressure-volume diagram explain the working of an air standard Diesel cycle and state the assumptions made.

Data for Q9

Saturated Water and Steam (Temperature) Tables

(t)	(p)	(v_f)	(v_g)	(h_f)	(h_{fg})	(h_g)	(s_f)	(s_{fg})	(s_g)	(t)
120	1.985 4	0.001 061	0.891 52	503.7	2 202.3	2 706.0	1.528	5.601	7.129	**120**
122	2.114 5	0.001 063	0.840 45	512.2	2 196.6	2 708.8	1.549	5.559	7.108	**122**
124	2.250 4	0.001 064	0.792 83	520.7	2 190.9	2 711.6	1.570	5.517	7.087	**124**
126	2.393 3	0.001 066	0.748 40	529.2	2 185.2	2 714.4	1.592	5.475	7.067	**126**
128	2.543 5	0.001 068	0.706 91	537.8	2 179.4	2 717.2	1.613	5.433	7.046	**128**
130	2.701 3	0.001 070	0.668 14	546.3	2 173.6	2 719.9	1.634	5.392	7.026	**130**
132	2.867 0	0.001 072	0.631 88	554.8	2 167.8	2 722.6	1.655	5.351	7.006	**132**
134	3.040 7	0.001 074	0.597 95	563.4	2 161.9	2 725.3	1.676	5.310	6.986	**134**
136	3.222 9	0.001 076	0.566 18	572.0	2 155.9	2 727.9	1.697	5.270	6.967	**136**
138	3.413 8	0.001 078	0.536 41	580.5	2 150.0	2 730.5	1.718	5.229	6.947	**138**
140	3.613 9	0.001 080	0.508 49	589.1	2 144.0	2 733.1	1.739	5.189	6.928	**140**
142	3.823 1	0.001 082	0.482 30	597.7	2 137.9	2 735.6	1.760	5.150	6.910	**142**
144	4.042 0	0.001 084	0.457 71	606.3	2 131.8	2 738.1	1.780	5.111	6.891	**144**
146	4.270 9	0.001 086	0.434 60	614.9	2 125.7	2 740.6	1.801	5.071	6.872	**146**
148	4.510 1	0.001 089	0.412 88	623.5	2 119.5	2 743.0	1.821	5.033	6.854	**148**
150	4.760 0	0.001 091	0.392 45	632.2	2 113.2	2 745.4	1.842	4.994	6.836	**150**
155	5.433 3	0.001 096	0.346 44	653.8	2 097.4	2 751.2	1.892	4.899	6.791	**155**
160	6.180 6	0.001 102	0.306 76	675.5	2 081.2	2 756.7	1.943	4.805	6.748	**160**
165	7.007 7	0.001 108	0.272 40	697.2	2 064.8	2 762.0	1.992	4.713	6.705	**165**
170	7.920 2	0.001 114	0.242 55	719.1	2 048.0	2 767.1	2.042	4.621	6.663	**170**

Specific Enthalpy of Superheated Steam

(p)	(t_s)	100	150	200	250	300	350	400	500	600	700	800
2.5	127.4	..	2 764.5	2 868.0	2 969.6	3 070.9	3 172.8	3 275.9	3 486.5	3 703.6	3 927.3	4 157.6
3.0	133.5	..	2 760.4	2 865.5	2 967.9	3 069.7	3 171.9	3 275.2	3 486.0	3 703.2	3 927.0	4 157.3
3.5	138.9	..	2 756.3	2 863.0	2 966.2	3 068.4	3 170.9	3 274.4	3 485.4	3 702.7	3 926.7	4 157.1
4.0	143.6	..	2 752.0	2 860.4	2 964.5	3 067.2	3 170.0	3 273.6	3 484.9	3 702.3	3 926.4	4 156.9
4.5	147.9	..	2 746.7	2 857.8	2 962.8	3 066.0	3 169.1	3 272.9	3 484.3	3 701.9	3 926.1	4 156.7
5.0	151.8	..	..	2 855.1	2 961.1	3 064.8	3 168.1	3 272.1	3 483.8	3 701.5	3 925.8	4 156.4
6.0	158.8	..	..	2 849.7	2 957.6	3 062.3	3 166.2	3 270.6	3 482.7	3 700.7	3 925.1	4 155.9
7.0	165.0	..	..	2 844.2	2 954.0	3 059.8	3 164.3	3 269.0	3 481.6	3 699.9	3 924.5	4 155.5
8.0	170.4	..	..	2 838.6	2 950.4	3 057.3	3 162.4	3 267.5	3 480.5	3 699.1	3 923.9	4 155.0
9.0	175.4	..	..	2 832.7	2 946.8	3 054.7	3 160.5	3 266.0	3 479.4	3 698.2	3 923 3	4 154.5

Specific Entropy of Superheated Steam

(p)	(t_s)	100	150	200	250	300	350	400	500	600	700	800
2.5	127.4	..	7.169	7.400	7.604	7.789	7.960	8.119	8.410	8.674	8.917	9.142
3.0	133.5	..	7.077	7.312	7.518	7.703	7.874	8.034	8.326	8.590	8.833	9.058
3.5	138.5	..	6.998	7.237	7.444	7.631	7.802	7.962	8.254	8.518	8.761	8.986
4.0	143.6	..	6.929	7.171	7.380	7.568	7.740	7.899	8.192	8.456	8.699	8.925
4.5	147.9	..	6.866	7.112	7.323	7.512	7.684	7.844	8.137	8.402	8.645	8.870
5.0	151.8	..	..	7.059	7.272	7.461	7.634	7.795	8.088	8.353	8.596	8.821
6.0	158.8	..	..	6.966	7.183	7.374	7.548	7.709	8.003	8.268	8.511	8.737
7.0	165.0	..	..	6.886	7.107	7.300	7.475	7.636	7.931	8.196	8.440	8.665
8.0	170.4	..	..	6.815	7.040	7.235	7.411	7.573	7.868	8.134	8.377	8.603
9.0	175.4	..	..	6.751	6.980	7.177	7.354	7.517	7.812	8.079	8.323	8.549

Specific Volume of Superheated Steam

(p)	(t_s)	100	150	200	250	300	350	400	500	600	700	800
2.5	127.4	..	0.764 1	0.862 0	0.957 4	1.052	1.145	1.239	1.424	1.610	1.795	1.980
3.0	133.5	..	0.633 7	0.716 4	0.796 4	0.875 3	0.953 5	1.031	1.187	1.341	1.496	1.650
3.5	138.9	..	0.540 6	0.612 3	0.681 4	0.749 3	0.816 6	0.883 5	1.017	1.149	1.282	1.414
4.0	143.6	..	0.470 7	0.534 3	0.595 2	0.654 9	0.713 9	0.772 5	0.889 2	1.005	1.121	1.237
4.5	147.9	..	0.416 5	0.473 8	0.528 4	0.581 7	0.634 3	0.686 5	0.790 5	0.893 9	0.997 1	1.100
5.0	151.8	..	..	0.425 0	0.474 4	0.522 6	0.570 1	0.617 2	0.710 8	0.804 0	0.896 9	0.989 6
6.0	158.8	..	..	0.352 0	0.393 9	0.434 4	0.474 2	0.513 6	0.591 8	0.669 6	0.747 1	0.824 5
7.0	165.0	..	..	0.299 9	0.336 4	0.371 4	0.405 7	0.439 6	0.506 9	0.573 7	0.640 2	0.706 6
8.0	170.4	..	..	0.260 8	0.293 2	0.324 1	0.354 3	0.384 2	0.443 2	0.501 7	0.560 0	0.618 1
9.0	175.4	..	..	0.230 3	0.259 6	0.287 4	0.314 4	0.341 0	0.393 6	0.445 8	0.497 6	0.549 3