17352

21314

3 Hours / 100 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory*.

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

(8) Use of Steam tables, Mollier's chart is permitted.

Marks

1. Attempt any <u>FIVE</u> of the following: **20**

a) What do you mean by extensive and intensive properties ? Give two examples of each.

b) State zeroth law, first law and second law (both statements) of thermodynamics.

c) Write generalised steady flow energy equation. State meaning of each term in it. Apply SFEE to nozzle and write final equation.

d) CO_2 passing through a heat exchanger at a rate of 100kg/hr is cooled down from 800°C to 50°C. Write SFEE. Determine rate of heat removal, assuming that change in pressure, kinetic and potential are negligible. Take C_p = 1.08 kJ/kg.K.

P.T.O.

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e) Compare heat engine cycle with refrigeration cycle.

f) 1.5kg of air is compressed in a quasistatic process from 0.1MPa to 0.7MPa for which (PV) is constant. If initial volume of air is 1.3 m^3, find workdown by piston to compress the air.

g) State the value of universal gas constant with proper unit. Determine characteristic gas constant for water from universal gas constant.

2. Attempt any <u>FOUR</u> of the following: **16**

a) One kg mass of air expands reversibly from 6.5 bar and 0.0135m^3 to a final volume of 0.1m^3. Find final pressure, final temperature and work done if the expansion is adiabatic.

b) 0.1kg of nitrogen gas is confined in a vessel. Initial volume of gas is 0.1m^3. Heat is transferred to nitrogen at constant pressure of 1.2 bar till volume changes to 0.075m^3. Determine final temperature of gas and work transferred.

c) Draw a neat sketch of simple carburettor and label its components.

d) With the help of p-h diagram, state the effect of subcooling and superheating on COP of VCR cycle.

e) Draw a neat sketch of shell and tube heat exchanger. Show shell side and tube side flow.

3. Attempt any <u>FOUR</u> of the following: **16**

a) State the necessity of mountings and accessories in boilers. State any two mountings and two accessories used in boiler with their functions.

b) Represent Rankine cycle on P-V diagram (Show proper arrows). State various processes in it. Write down the formula for calculating thermal efficiency of Rankine cycle.

c) State the function of condenser in steam power plant. Draw a neat sketch of surface condenser.

Marks

d) Read steam table and write the following values:

i) Liquid enthalpy and vapour enthalpy at 4 bar.

ii) Saturation pressure for 150°C.

iii) Enthalpy of steam at 1.5 bar and 350°C.

iv) Liquid entropy at 130°C.

e) Determine the amount of heat, which should be supplied to 2kg of water at 25°C to convert it into steam at 5 bar and 0.9 dry.
Take, C_{Pw} = 4.18kJ/kg.K and at 5 bar hf = 640 kJ/kg and h_{fg} = 2107 kJ/kg.

4. Attempt any <u>FOUR</u> of the following: **16**

a) Define:

i) Free air delivered

ii) Isothermal efficiency.

Also give the equations for them.

b) Draw a neat sketch of vane compressor and state its working principle.

c) Represent multistage compression with intercooling (perfect) on P-V diagram. State advantages of multistage compression.

d) Draw a neat layout of vapour compression refrigeration cycle and state the function of each component.

e) With neat sketch explain working principle of natural draught cooling tower.

5. Attempt any <u>FOUR</u> of the following: **16**

a) Draw a neat sketch of two stroke engine and state the function of each port and crankcase in it.

b) Draw valve timing diagram for 4-stroke petrol engine. Represent all salient point on it.

c) Compare spark ignition engines with compression ignition engines.

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d) The minimum pressure and temperature in an Otto cycle are 100kpa and 27°C. The amount of heat added to air per cycle is 1500 kJ/kg. Determine pressures and temperatures at all points in cycle.

e) The stroke and cylinder diameter of C.I. engine are 250mm and 150mm respectively. If clearance volume is $0.0004m^3$ and volume at cut-off is $0.000621m^3$. Determine compression, ratio, cut-off ratio and thermal efficiency of engine.

f) Air enters the compressor of gas turbine plant working on Brayton cycle at 1.01325 bar and 27°C. The pressure ratio in the cycle is 6. Calculate maximum temperature in the cycle if $W_T = 2.5*Wc$ where $W_T \rightarrow$ Turbine work and Wc - compressor work.

6. Attempt any <u>FOUR</u> of the following: **16**

a) Consider a composite wall made up of three materials having different thickness and different thermal conductivities. Assume temperatures at interface and prepare electrical analogy circuit. And hence write equation for heat transfer through the wall.

b) The inner surface of a plane brick wall is at 60°C and outer surface is at 35°C. Calculate heat transfer per m^2 of surface area of wall, which is 220mm thick. Thermal conductivity for brick wall is 0.51W/m°C.

c) Hot air at temperature of 60°C is flowing through a steel pipe of 10cm diameter. The pipe is covered with a layer of insulation of 5cm thickness and thermal conductivity 0.23 w/mK. The inside and outside heat transfer coefficients are 58 and 12 $W/m^2.k$. Atmospheric temperature is 25°C. Find rate of heat loss from 50m length pipe. Neglect steel pipe resistance.

d) Define : Absorptivity, Transmissivity and Reflectivity. State values of above for black body.

e) State Fourier's law of heat conduction and its equation. State Stefan-Boltzman law and value of Stefan-Boltzman constant.

TABLE 4

Specific Enthalpy of Superheated Steam

18

Absolute Pressure in bar (p)	Saturation Temperature in °C (t_s)	Specific enthalphy (h) in kJ/kg at various temperatures in °C										
		100	150	200	250	300	350	400	500	600	700	800
0.02	17.5	2 688.5	2 783.7	2 880.0	2 977.7	3 076.8	3 177.5	3 279.7	3 489.2	3 705.6	3 928.8	4 158.7
0.04	29.0	2 688.3	2 783.5	2 879.9	2 977.6	3 076.8	3 177.4	3 279.7	3 489.2	3 705.6	3 928.8	4 158.7
0.06	36.2	2 688.0	2 783.4	2 879.8	2 977.6	3 076.7	3 177.4	3 279.6	3 489.2	3 705.6	3 928.8	4 158.7
0.08	41.5	2 687.8	2 783.2	2 879.7	2 977.5	3 076.7	3 177.3	3 279.6	3 489.1	3 705.5	3 928.8	4 158.7
0.10	45.8	2 687.5	2 783.1	2 879.6	2 977.4	3 076.6	3 177.3	3 279.6	3 489.1	3 705.5	3 928.8	4 158.7
0.15	54.0	2 686.9	2 782.4	2 879.5	2 977.3	3 076.5	3 177.7	3 279.5	3 489.1	3 705.5	3 928.7	4 158.7
0.20	60.1	2 686.3	2 782.3	2 879.2	2 977.1	3 076.4	3 177.1	3 279.4	3 489.0	3 705.4	3 928.7	4 158.7
0.25	65.0	2 685.7	2 782.0	2 879.0	2 977.0	3 076.3	3 177.0	3 279.3	3 489.0	3 705.4	3 928.7	4 158.6
0.30	69.1	2 685.1	2 781.6	2 878.7	2 976.8	3 076.1	3 176.9	3 279.3	3 488.9	3 705.4	3 928.7	4 158.6
0.35	72.7	2 684.5	2 781.2	2 878.5	2 976.7	3 076.0	3 176.8	3 279.2	3 488.9	3 705.3	3 928.7	4 158.6
0.40	75.9	2 683.8	2 780.9	2 878.2	2 976.5	3 075.9	3 176.8	3 279.1	3 488.8	3 705.3	3 928.6	4 158.6
0.45	78.7	2 683.2	2 780.5	2 878.0	2 976.3	3 075.8	3 176.7	3 279.1	3 488.8	3 705.2	3 928.6	4 158.5
0.50	81.3	2 682.6	2 780.1	2 877.7	2 976.1	3 075.7	3 176.6	3 279.0	3 488.7	3 705.2	3 928.6	4 158.5
0.60	86.0	2 681.3	2 779.4	2 877.3	2 975.8	3 075.4	3 176.4	3 278.8	3 488.6	3 705.1	3 928.5	4 158.5
0.70	90.0	2 680.0	2 778.6	2 876.8	2 975.5	3 075.2	3 176.2	3 278.7	3 488.5	3 705.0	3 928.4	4 158.4
0.80	93.5	2 678.8	2 777.8	2 876.3	2 975.2	3 075.0	3 176.0	3 278.5	3 488.4	3 705.0	3 928.4	4 158.4
0.90	96.7	2 677.5	2 777.1	2 875.8	2 974.8	3 074.7	3 175.8	3 278.4	3 488.3	3 704.9	3 928.3	4 158.3
1.00	99.6	2 676.2	2 776.3	2 875.4	2 974.5	3 074.5	3 175.6	3 278.2	3 488.1	3 704.8	3 928.2	4 158.3
1.50	111.4	..	2 772.5	2 872.9	2 972.9	3 073.3	3 174.7	3 277.5	3 487.6	3 704.4	3 927.9	4 158.0
2.00	120.2	..	2 768.5	2 870.5	2 971.2	3 072.1	3 173.8	3 276.7	3 487.0	3 704.0	3 927.6	4 157.8

Saturated Water and Steam (Temperature) Tables 5

(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**
175	8.924 4	0.001 121	0.216 54	741.1	2 030.7	2 771.8	2.091	4.531	6.622	**175**
180	10.027	0.001 128	0.193 80	763.1	2 013.2	2 776.3	2.139	4.443	6.582	**180**
185	11.233	0.001 135	0.173 86	785.3	1 995.1	2 780.4	2.187	4.355	6.542	**185**
190	12.551	0.001 142	0.156 32	807.5	1 976.8	2 784.3	2.236	4.268	6.504	**190**
195	13.987	0.001 149	0.140 84	829.9	1 957.9	2 787.8	2.283	4.182	6.465	**195**
200	15.549	0.001 156	0.127 16	852.4	1 938.5	2 790.9	2.331	4.097	6.428	**200**
205	17.243	0.001 164	0.115 03	875.0	1 918.8	2 793.8	2.378	4.013	6.391	**205**
210	19.077	0.001 172	0.104 24	897.7	1 898.5	2 796.2	2.425	3.929	6.354	**210**
215	21.060	0.001 181	0.094 625	920.6	1 877.7	2 798.3	2.471	3.846	6.317	**215**
220	23.198	0.001 190	0.086 038	943.7	1 856.2	2 799.9	2.518	3.764	6.282	**220**

Marks

Saturated Water and Steam (Pressure) Tables

(p)	(t)	(v_f)	(v_g)	(h_f)	(h_{fg})	(h_g)	(s_f)	(s_{fg})	(s_g)	(t)
2.1	121.8	0.001 062	0.845 86	511.3	2 197.2	2 708.5	1.547	5.564	7.111	**2.1**
2.2	123.3	0.001 064	0.809 80	517.6	2 193.0	2 710.6	1.563	5.532	7.095	**2.2**
2.3	124.7	0.001 065	0.776 77	523.7	2 188.9	2 712.6	1.578	5.502	7.080	**2.3**
2.4	126.1	0.001 066	0.746 41	529.6	2 184.9	2 714.5	1.593	5.473	7.066	**2.4**
2.5	127.4	0.001 068	0.718 40	535.3	2 181.1	2 716.4	1.607	5.445	7.052	**2.5**
2.6	128.7	0.001 069	0.692 47	540.9	2 177.3	2 718.2	1.621	5.418	7.039	**2.6**
2.7	130.0	0.001 070	0.668 40	546.2	2 173.7	2 719.9	1.634	5.392	7.026	**2.7**
2.8	131.2	0.001 071	0.646 00	551.4	2 170.1	2 721.5	1.647	5.367	7.014	**2.8**
2.9	132.4	0.001 072	0.625 09	556.5	2 166.6	2 723.1	1.660	5.342	7.002	**2.9**
3.0	133.5	0.001 074	0.605 53	561.5	2 163.2	2 724.7	1.672	5.319	6.991	**3.0**
3.1	134.7	0.001 075	0.587 18	566.2	2 159.9	2 726.1	1.683	5.297	6.980	**3.1**
3.2	135.8	0.001 076	0.569 95	570.9	2 156.7	2 727.6	1.695	5.274	6.969	**3.2**
3.3	136.8	0.001 077	0.553 73	575.5	2 153.5	2 729.0	1.706	5.253	6.959	**3.3**
3.4	137.9	0.001 078	0.538 43	579.9	2 150.4	2 730.3	1.717	5.232	6.949	**3.4**
3.5	138.9	0.001 079	0.523 97	584.3	2 147.3	2 731.6	1.727	5.212	6.939	**3.5**
3.6	139.9	0.001 080	0.510 29	588.5	2 144.4	2 732.9	1.738	5.192	6.930	**3.6**
3.7	140.8	0.001 081	0.497 33	592.7	2 141.4	2 734.1	1.748	5.173	6.921	**3.7**
3.8	141.8	0.001 082	0.485 02	596.7	2 138.6	2 735.3	1.758	5.154	6.912	**3.8**
3.9	142.7	0.001 083	0.473 33	600.8	2 135.7	2 736.5	1.767	5.136	6.903	**3.9**
4.0	143.6	0.001 084	0.462 20	604.7	2 132.9	2 737.6	1.776	5.118	6.894	**4.0**
4.1	144.5	0.001 085	0.451 59	608.5	2 130.2	2 738.7	1.786	5.100	6.886	**4.1**
4.2	145.4	0.001 086	0.441 47	612.3	2 127.5	2 739.8	1.795	5.083	6.878	**4.2**
4.3	146.3	0.001 087	0.431 81	616.0	2 124.9	2 740.9	1.803	5.067	6.870	**4.3**
4.4	147.1	0.001 088	0.422 57	619.6	2 122.3	2 741.9	1.812	5.050	6.862	**4.4**
4.5	147.9	0.001 089	0.413 73	623.2	2 119.7	2 742.9	1.820	5.035	6.855	**4.5**
4.6	148.7	0.001 090	0.405 26	626.7	2 117.2	2 743.9	1.829	5.018	6.847	**4.6**
4.7	149.5	0.001 090	0.397 14	630.1	2 114.7	2 744.8	1.837	5.003	6.840	**4.7**
4.8	150.3	0.001 091	0.389 34	633.5	2 112.2	2 745.7	1.845	4.988	6.833	**4.8**
4.9	151.1	0.001 092	0.381 86	636.8	2 109.8	2 746.6	1.853	4.973	6.826	**4.9**
5.0	151.8	0.001 093	0.374 66	640.1	2 107.4	2 747.5	1.860	4.959	6.819	**5.0**

Marks

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