The Open University of Sri Lanka
Faculty of Engineering Technology

314

Study Programme	:	Bachelor of Science Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX3401 Fluid Mechanics and Thermodynamics**
Academic Year	:	2022/23
Date	:	15th February 2024
Time	:	0930 hrs-1230hrs
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. Answer all **five (05)** Questions. All questions carry equal marks.
3. Relevant charts/ codes are provided.
4. This is a Closed Book Test (CBT).
5. Answers should be in clear handwriting.
6. Do not use Red colour pen.
7. Take the specific gas constant (R) for air as $0.287 kJ/\ kg\ K$.
8. Density of Water is $1000 kg/m^3$
9. For air $C_v = 0.718\ kJ/kgK$ and $C_p = 1.005\ kJ/kgK$
10. Take acceleration due to gravity as 9.81 ms^{-2}.

Q1 (a) Draw p – V diagram for the Carnot cycle and explain all the processes. (6 marks)

(b) A steam power plant works on Carnot cycle works between the pressure limits of 7 MPa and 7 kPa. Determine thermal efficiency, turbine work and compression work per kg of steam. (14 marks)
You may use the thermodynamic properties of steam provided at the end of the question paper.

Q2 (a) Draw p -V diagram and T-s diagram for Diesel cycle and name all the processes. (5 marks)

(b) An air-standard Diesel cycle has a compression ratio of 18. The heat transferred to the working fluid per cycle is 2000 kJ/kg. At the beginning of the compression process the pressure is 100 kPa and the temperature is 25°C. Find the following.

(i) Pressure and temperature at each point in the cycle, (10 marks)
(ii) Thermal efficiency (5 marks)

Q3 (a) Name any three thermodynamics processes. (5 marks)

(b) Three (3) kg of air at 1.5 bar pressure and 77°C temperature at state 1 is compressed polytropically to state 2 at pressure 7.5 bar, the index of compression being 1.2. It is then cooled at constant temperature to its original state.

(i) Draw p -V diagram for all processes. (5 marks)
(ii) Find the net work done and the heat transferred. (10 marks)

Q4 (a) What are the different types of flow measuring devices? (5 marks)

(b) (i) Derive an equation for the pressure difference $(p_A - p_B)$ in terms of the specific weight of the flowing fluid γ_1, the specific weight of the manometric fluid γ_2 , and the various heights indicated in figure Q 4. (15 marks)

(ii) For $\gamma_1 = 9.8\ kN/m^3$, $\gamma_2 = 15.6\ kN/m^3$ and $h_1 = 1.0\ m$, $h_2 = 0.5\ m$, what is the value of the pressure difference, $(p_A - p_B)$?

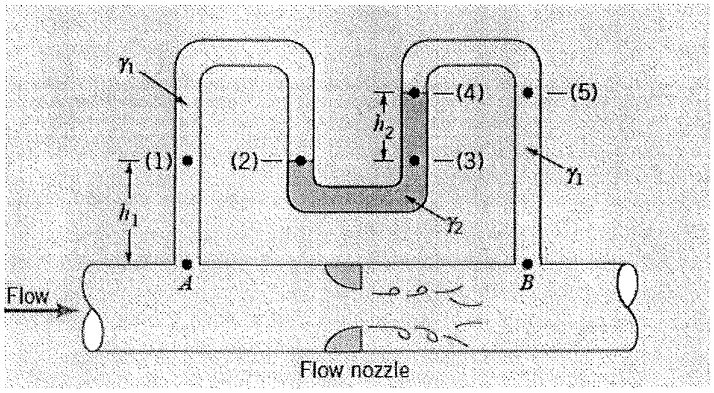

Figure Q4

Q5 (a) Define the term "centre of pressure "for a plane surface submerged in a liquid. (5 marks)

(b) Gate AB shown in figure Q5, is 1.0 m long and 0.9 m wide. Calculate the hydrostatic force on the gate and the position of its center of pressure. (15 marks)

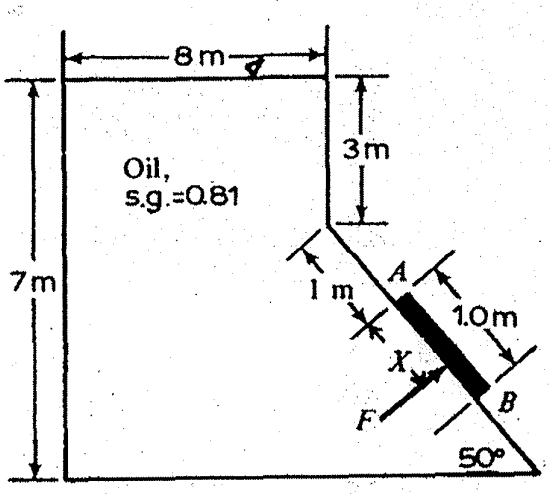

Figure Q5

END

*** All rights reserved***

Saturated Water and Steam (Pressure-based)

$p_{tp} = 611.657$ Pa $= 0.000611657$ MPa

p	T_{sat}	Volume, m^3/kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
MPa	°C	v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
p_{tp}	**0.01**	0.00100021	205.991	**0**	2374.9	0.00	2500.9	2500.9	**0**	9.1555	9.1555
0.0007	1.881	0.00100011	181.217	7.89	2377.4	7.89	2504.3	2496.5	0.02878	9.1058	9.0770
0.0008	3.761	0.00100008	159.640	15.81	2380.1	15.81	2507.8	2492.0	0.05748	9.0567	8.9992
0.0009	5.444	0.00100009	142.757	22.89	2382.4	22.89	2510.9	2488.0	0.08297	9.0135	8.9305
0.0010	6.970	0.00100014	129.178	29.30	2384.5	29.30	2513.7	2484.4	0.10591	8.9749	8.8690
0.0012	9.654	0.00100032	108.670	40.57	2388.2	40.57	2518.6	2478.0	0.14595	8.9082	8.7623
0.0014	11.969	0.00100054	93.899	50.28	2391.3	50.28	2522.8	2472.5	0.18015	8.8521	8.6719
0.0016	14.010	0.00100080	82.743	58.83	2394.1	58.83	2526.5	2467.7	0.21004	8.8035	8.5935
0.0018	15.837	0.00100108	74.011	66.49	2396.7	66.49	2529.9	2463.4	0.23662	8.7608	8.5241
0.0020	17.495	0.00100136	66.987	73.43	2398.9	73.43	2532.9	2459.4	0.26056	8.7226	8.4620
0.0024	20.414	0.00100193	56.375	85.65	2402.9	85.65	2538.2	2452.5	0.30239	8.6567	8.3544
0.0028	22.935	0.00100249	48.729	96.19	2406.4	96.19	2542.8	2446.6	0.33816	8.6012	8.2631
0.0032	25.158	0.00100305	42.952	105.49	2409.4	105.49	2546.8	2441.3	0.36945	8.5533	8.1838
0.0036	27.152	0.00100358	38.430	113.83	2412.1	113.83	2550.4	2436.6	0.39729	8.5110	8.1138
0.0040	28.960	0.00100410	34.791	121.39	2414.5	121.39	2553.7	2432.3	0.42239	8.4734	8.0510
0.0045	31.012	0.00100473	31.131	129.96	2417.3	129.96	2557.4	2427.4	0.45069	8.4313	7.9806
0.0050	32.874	0.00100533	28.185	137.74	2419.8	137.75	2560.7	2423.0	0.47620	8.3938	7.9176
0.0055	34.581	0.00100590	25.762	144.87	2422.1	144.88	2563.8	2418.9	0.49945	8.3599	7.8605
0.0060	36.159	0.00100645	23.733	151.47	2424.2	151.48	2566.6	2415.2	0.52082	8.3290	7.8082
0.0065	37.627	0.00100699	22.009	157.60	2426.2	157.61	2569.3	2411.6	0.54060	8.3007	7.7601
0.0070	39.000	0.00100750	20.524	163.34	2428.0	163.35	2571.7	2408.4	0.55903	8.2745	7.7154
0.0075	40.290	0.00100800	19.233	168.74	2429.8	168.75	2574.0	2405.3	0.57627	8.2501	7.6738
0.0080	41.509	0.00100848	18.099	173.83	2431.4	173.84	2576.2	2402.4	0.59249	8.2273	7.6348
0.0085	42.663	0.00100895	17.095	178.66	2433.0	178.67	2578.3	2399.6	0.60780	8.2060	7.5982
0.0090	43.761	0.00100940	16.199	183.24	2434.4	183.25	2580.2	2397.0	0.62230	8.1858	7.5635
0.0095	44.807	0.00100984	15.396	187.62	2435.8	187.63	2582.1	2394.5	0.63607	8.1668	7.5308
0.010	45.806	0.00101027	14.670	191.80	2437.2	191.81	2583.9	2392.1	0.64920	8.1488	7.4996
0.011	47.683	0.00101110	13.412	199.64	2439.7	199.65	2587.2	2387.5	0.67372	8.1154	7.4417
0.012	49.419	0.00101188	12.358	206.90	2442.0	206.91	2590.3	2383.4	0.69628	8.0849	7.3887
0.013	51.034	0.00101263	11.462	213.66	2444.1	213.67	2593.1	2379.4	0.71717	8.0570	7.3398
0.014	52.547	0.00101335	10.691	219.98	2446.1	219.99	2595.8	2375.8	0.73664	8.0311	7.2945
0.016	55.313	0.00101471	9.4306	231.55	2449.7	231.57	2600.6	2369.1	0.77201	7.9846	7.2126
0.018	57.798	0.00101597	8.4431	241.94	2453.0	241.96	2605.0	2363.0	0.80355	7.9437	7.1402
0.020	60.058	0.00101716	7.6480	251.40	2455.9	251.42	2608.9	2357.5	0.83202	7.9072	7.0752
0.024	64.053	0.00101934	6.4453	268.13	2461.2	268.15	2615.9	2347.7	0.88191	7.8442	6.9623
0.028	67.518	0.00102131	5.5778	282.63	2465.6	282.66	2621.8	2339.2	0.92472	7.7912	6.8664
0.032	70.586	0.00102312	4.9215	295.49	2469.6	295.52	2627.1	2331.6	0.96228	7.7453	6.7830
0.036	73.345	0.00102480	4.4072	307.05	2473.1	307.09	2631.8	2324.7	0.99579	7.7050	6.7092
0.040	75.857	0.00102638	3.9930	317.58	2476.4	317.62	2636.1	2318.4	1.0261	7.6690	6.6429
0.045	78.715	0.00102821	3.5759	329.57	2480.0	329.62	2640.9	2311.2	1.0603	7.6288	6.5686
0.050	81.317	0.00102993	3.2400	340.49	2483.2	340.54	2645.2	2304.7	1.0912	7.5930	6.5018

Continued ...

Saturated Water and Steam (Pressure-based), Contd.

p	T_{sat}	Volume, m^3/kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
MPa	°C	v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
5.1	265.181	0.00128971	0.038628	1154.3	2596.4	1160.9	2793.4	1632.5	2.9323	5.9648	3.0325
5.2	266.403	0.00129302	0.037840	1160.3	2595.7	1167.0	2792.5	1625.5	2.9435	5.9561	3.0126
5.3	267.608	0.00129632	0.037081	1166.2	2595.1	1173.1	2791.6	1618.5	2.9546	5.9475	2.9930
5.4	268.795	0.00129961	0.036348	1172.1	2594.4	1179.1	2790.7	1611.5	2.9654	5.9391	2.9736
5.5	269.965	0.00130290	0.035642	1177.9	2593.7	1185.1	2789.7	1604.6	2.9762	5.9307	2.9545
5.6	271.120	0.00130618	0.034959	1183.7	2592.9	1191.0	2788.7	1597.8	2.9868	5.9224	2.9356
5.7	272.258	0.00130946	0.034300	1189.3	2592.2	1196.8	2787.7	1590.9	2.9972	5.9142	2.9170
5.8	273.382	0.00131273	0.033662	1195.0	2591.5	1202.6	2786.7	1584.1	3.0075	5.9061	2.8985
5.9	274.490	0.00131600	0.033045	1200.5	2590.7	1208.3	2785.7	1577.4	3.0177	5.8981	2.8803
6.0	275.585	0.00131926	0.032448	1206.0	2589.9	1213.9	2784.6	1570.7	3.0278	5.8901	2.8623
6.1	276.666	0.00132253	0.031870	1211.4	2589.1	1219.5	2783.5	1564.0	3.0377	5.8823	2.8445
6.2	277.733	0.00132579	0.031309	1216.9	2588.3	1225.1	2782.4	1557.3	3.0476	5.8745	2.8269
6.3	278.787	0.00132905	0.030766	1222.1	2587.4	1230.5	2781.2	1550.7	3.0573	5.8668	2.8095
6.4	279.829	0.00133230	0.030238	1227.5	2586.6	1236.0	2780.1	1544.1	3.0669	5.8592	2.7923
6.5	280.858	0.00133556	0.029727	1232.7	2585.7	1241.4	2778.9	1537.5	3.0764	5.8516	2.7752
6.6	281.875	0.00133882	0.029230	1237.9	2584.8	1246.7	2777.7	1530.9	3.0858	5.8441	2.7583
6.7	282.880	0.00134208	0.028747	1243.0	2583.8	1252.0	2776.4	1524.4	3.0951	5.8367	2.7416
6.8	283.874	0.00134533	0.028278	1248.2	2582.9	1257.3	2775.2	1517.9	3.1043	5.8293	2.7250
6.9	284.857	0.00134859	0.027822	1253.2	2581.9	1262.5	2773.9	1511.4	3.1134	5.8220	2.7086
7.0	285.829	0.00135186	0.027378	1258.2	2581.0	1267.7	2772.6	1505.0	3.1224	5.8148	2.6924
7.1	286.790	0.00135512	0.026947	1263.2	2580.0	1272.8	2771.3	1498.5	3.1313	5.8076	2.6762
7.2	287.741	0.00135839	0.026526	1268.1	2579.0	1277.9	2770.0	1492.1	3.1402	5.8004	2.6603
7.3	288.682	0.00136166	0.026117	1273.0	2577.9	1282.9	2768.6	1485.7	3.1489	5.7933	2.6444
7.4	289.614	0.00136493	0.025718	1277.8	2577.0	1287.9	2767.3	1479.3	3.1576	5.7863	2.6287
7.5	290.535	0.00136821	0.025330	1282.6	2575.9	1292.9	2765.9	1473.0	3.1662	5.7793	2.6131
7.6	291.448	0.00137149	0.024951	1287.5	2574.9	1297.9	2764.5	1466.6	3.1747	5.7723	2.5976
7.7	292.351	0.00137477	0.024581	1292.2	2573.8	1302.8	2763.1	1460.3	3.1832	5.7654	2.5823
7.8	293.245	0.00137806	0.024221	1297.0	2572.7	1307.7	2761.6	1454.0	3.1915	5.7586	2.5671
7.9	294.131	0.00138136	0.023869	1301.6	2571.6	1312.5	2760.2	1447.7	3.1998	5.7518	2.5519
8.0	295.008	0.00138467	0.023526	1306.2	2570.5	1317.3	2758.7	1441.4	3.2081	5.7450	2.5369
8.1	295.876	0.00138797	0.023190	1310.9	2569.4	1322.1	2757.2	1435.1	3.2162	5.7383	2.5220
8.2	296.737	0.00139129	0.022863	1315.4	2568.2	1326.8	2755.7	1428.8	3.2243	5.7316	2.5072
8.3	297.589	0.00139461	0.022542	1320.0	2567.0	1331.6	2754.1	1422.6	3.2324	5.7249	2.4925
8.4	298.434	0.00139795	0.022229	1324.6	2565.9	1336.3	2752.6	1416.3	3.2403	5.7183	2.4779
8.5	299.271	0.00140128	0.021923	1329.0	2564.7	1340.9	2751.0	1410.1	3.2483	5.7117	2.4634
8.6	300.100	0.00140463	0.021624	1333.5	2563.4	1345.6	2749.4	1403.9	3.2561	5.7051	2.4490
8.7	300.922	0.00140799	0.021332	1338.0	2562.2	1350.2	2747.8	1397.7	3.2639	5.6986	2.4347
8.8	301.737	0.00141135	0.021045	1342.4	2561.0	1354.8	2746.2	1391.5	3.2717	5.6921	2.4204
8.9	302.544	0.00141473	0.020765	1346.7	2559.8	1359.3	2744.6	1385.3	3.2793	5.6856	2.4062
9.0	303.345	0.00141811	0.020490	1351.1	2558.5	1363.9	2742.9	1379.1	3.2870	5.6791	2.3922

Continued ...