ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF

MECHANICAL, AUTOMOTIVE AND PRODUCTION ENGINEERING

SECOND SEMESTER EXAMINATIONS

2016/2017 ACADEMIC SESSION

COURSE: GNE 236 – Basic Thermodynamics (2 Units)

CLASS: 200 Level General Engineering

TIME ALLOWED: 2 Hours

INSTRUCTIONS: Answer any four questions

HOD'S SIGNATURE

Date: July/August, 2017

Question 1

(a) Define the following terms:

(i) Property (ii) Nozzle (iii) Turbine

(iv) First law of thermodynamics (v) State

(b) Show that

(i) for Non Flow Energy Equation; $Q_{12} - W_{12} = U_2 - U_1$

(ii) for Steady State Flow Equation; $h_1 + gz_1 + \frac{1}{2} C_1^2 + q_{12} = h_2 + gz_2 + \frac{1}{2} C_2^2 + w_{12}$

Question 2

(a) Show that for wet vapour, the specific volume as a property is given by

$$v = xv_g$$

Where, x = dryness fraction

v_g = specific volume of saturated vapour

(b) A certain fluid at 10 bar is contained in a cylinder behind a piston, the initial volume being 0.05 m^3. Calculate the work done by the fluid when it expands reversibly,

(i) At constant pressure to a final volume of 0.2 m^3

(ii) According to a linear law to a final volume of 0.2 m^3 and a final pressure of 2 bar

(iii) According to a law $pv = c$ to a final volume of 0.1 m^3

(iv) According to a law $pv^3 = c$

Question 3

(a) Explain briefly the following terms when measuring temperature:

(i) Thermodynamic Equilibrium (ii) Thermometric substances (iii) Zeroth law.
(iv) bi-metallic thermometer.

(b) Given that the resistance of a resistance thermometer measured at 0°C and 100°C are 1.00Ω and 1.39Ω, respectively. Assuming there is a linear relationship between resistance and temperature, determine the corresponding temperature when a resistance of 3.2Ω is measured.

Question 4

(a) In a steady flow process, show from first principle that

$$\dot{m} = \frac{C_1 A_1}{V_1} = \frac{C_2 A_2}{V_2} = \text{constant}$$

(b) A fluid flow steadily through a turbine at the rate of 2.5kg/s, it enters with a velocity of 30 m/s and a specific enthalpy of 2930 KJ/kg. At exit, the velocity is 120 m/s and the specific enthalpy is 2675 KJ/kg, the rate of heat loss from the fluid to the surrounding is 45.0 KJ/s as it passes through the turbine. Neglecting any change in potential energy, determine the power developed by the turbine.

Question 5

(a) Briefly define the following terms:

(i) Dryness fraction (ii) Pure substances (iii) wet –vapour phase

(iv) Saturation Temperature (v) Degree of superheat

(b) Steam at 700 kPa and 50% quality is contained in a piston-cylinder arrangement which has an initial volume of 0.0241 m^3. As a result of heating at constant pressure, the volume increases to 0.0540 m^3. Determine:

(i) The mass of steam present

(ii) The change in internal energy

(iii) The heat added during the process.

Question 6

(a) With the aid of well labelled diagrams, give the statement of the second law of thermodynamics as formulated by:

(i) Clausius (ii) Kelvin – Planck

(b) Show that for an isobaric process; $q_{12} = h_2 - h_1$.

Saturated Water and Steam

p [bar]	T_s [°C]	v_g [m³/kg]	u_f [kJ/kg]	u_g [kJ/kg]	h_f [kJ/kg]	h_{fg} [kJ/kg]	h_g [kJ/kg]	s_f [kJ/kg K]	s_{fg} [kJ/kg K]	s_g [kJ/kg K]
1.0	99.6	1.694	417	2506	417	2258	2675	1.303	6.056	7.359
1.1	102.3	1.549	429	2510	429	2251	2680	1.333	5.994	7.327
1.2	104.8	1.428	439	2512	439	2244	2683	1.361	5.937	7.298
1.3	107.1	1.325	449	2515	449	2238	2687	1.387	5.884	7.271
1.4	109.3	1.236	458	2517	458	2232	2690	1.411	5.835	7.246
1.5	111.4	1.159	467	2519	467	2226	2693	1.434	5.789	7.223
1.6	113.3	1.091	475	2521	475	2221	2696	1.455	5.747	7.202
1.7	115.2	1.031	483	2524	483	2216	2699	1.475	5.707	7.182
1.8	116.9	0.9774	491	2526	491	2211	2702	1.494	5.669	7.163
1.9	118.6	0.9292	498	2528	498	2206	2704	1.513	5.632	7.145
2.0	120.2	0.8856	505	2530	505	2202	2707	1.530	5.597	7.127
2.1	121.8	0.8461	511	2531	511	2198	2709	1.547	5.564	7.111
2.2	123.3	0.8100	518	2533	518	2193	2711	1.563	5.533	7.096
2.3	124.7	0.7770	524	2534	524	2189	2713	1.578	5.503	7.081
2.4	126.1	0.7466	530	2536	530	2185	2715	1.593	5.474	7.067
2.5	127.4	0.7186	535	2537	535	2182	2717	1.607	5.446	7.053
2.6	128.7	0.6927	541	2539	541	2178	2719	1.621	5.419	7.040
2.7	130.0	0.6686	546	2540	546	2174	2720	1.634	5.393	7.027
2.8	131.2	0.6462	551	2541	551	2171	2722	1.647	5.368	7.015
2.9	132.4	0.6253	556	2543	556	2168	2724	1.660	5.344	7.004
3.0	133.5	0.6057	561	2544	561	2164	2725	1.672	5.321	6.993
3.5	138.9	0.5241	584	2549	584	2148	2732	1.727	5.214	6.941
4.0	143.6	0.4623	605	2554	605	2134	2739	1.776	5.121	6.897
4.5	147.9	0.4139	623	2558	623	2121	2744	1.820	5.037	6.857
5.0	151.8	0.3748	639	2562	640	2109	2749	1.860	4.962	6.822
5.5	155.5	0.3427	655	2565	656	2097	2753	1.897	4.893	6.790
6	158.8	0.3156	669	2568	670	2087	2757	1.931	4.830	6.761
7	165.0	0.2728	696	2573	697	2067	2764	1.992	4.717	6.709
8	170.4	0.2403	720	2577	721	2048	2769	2.046	4.617	6.663
9	175.4	0.2149	742	2581	743	2031	2774	2.094	4.529	6.623
10	179.9	0.1944	762	2584	763	2015	2778	2.138	4.448	6.586

Superheated Steam*

p/[bar] (T_s/[°C])			T [°C]	200	250	300	350	400	450	500	600
5 (151.8)	v_g	0.3748	v	0.4252	0.4745	0.5226	0.5701	0.6172	0.6641	0.7108	0.8040
	u_g	2562	u	2644	2725	2804	2883	2963	3045	3129	3300
	h_g	2749	h	2857	2962	3065	3168	3272	3377	3484	3702
	s_g	6.822	s	7.060	7.271	7.460	7.633	7.793	7.944	8.087	8.351
6 (158.8)	v_g	0.3156	v	0.3522	0.3940	0.4344	0.4743	0.5136	0.5528	0.5919	0.6697
	u_g	2568	u	2640	2722	2801	2881	2962	3044	3128	3299
	h_g	2757	h	2851	2958	3062	3166	3270	3376	3483	3701
	s_g	6.761	s	6.968	7.182	7.373	7.546	7.707	7.858	8.001	8.267
7 (165.0)	v_g	0.2728	v	0.3001	0.3364	0.3714	0.4058	0.4397	0.4734	0.5069	0.5737
	u_g	2573	u	2636	2720	2800	2880	2961	3043	3127	3298
	h_g	2764	h	2846	2955	3060	3164	3269	3374	3482	3700
	s_g	6.709	s	6.888	7.106	7.298	7.473	7.634	7.786	7.929	8.195
8 (170.4)	v_g	0.2403	v	0.2610	0.2933	0.3242	0.3544	0.3842	0.4138	0.4432	0.5018
	u_g	2577	u	2631	2716	2798	2878	2960	3042	3126	3298
	h_g	2769	h	2840	2951	3057	3162	3267	3373	3481	3699
	s_g	6.663	s	6.817	7.040	7.233	7.409	7.571	7.723	7.866	8.132
9 (175.4)	v_g	0.2149	v	0.2305	0.2597	0.2874	0.3144	0.3410	0.3674	0.3937	0.4458
	u_g	2581	u	2628	2714	2796	2877	2959	3041	3126	3298
	h_g	2774	h	2835	2948	3055	3160	3266	3372	3480	3699
	s_g	6.623	s	6.753	6.980	7.176	7.352	7.515	7.667	7.811	8.077