ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA
DEPARTMENT OF MECHANICAL ENGINEERING

SECOND SEMESTER EXAMINATIONS

2017/2018 ACADEMIC SESSION

COURSE: GNE 236 – Basic Thermodynamics (2 Units)

CLASS: 200 Level General Engineering

TIME ALLOWED: 2hrs

INSTRUCTIONS: Answer any four (4) questions.

HOD'S SIGNATURE

Date: July/August, 2018

QUESTION 1

a. Find the temperature which has the same value on both the Celsius and Fahrenheit scales.

b. The pressure of steam inside a boiler as measured by pressure gauge is 1 N/m. The barometric pressure of the atmosphere is 765 mm of mercury. Find the absolute pressure of steam in N/m^2, kPa, and N/mm^2.

c. In a condenser of steam power plant, the vacuum is recorded as 760 mm of mercury. If the barometric reading is 760 mm of mercury. Find the absolute pressure in the condenser in N/m^2, N/mm^2, and bar.

QUESTION 2

a. State the Zeroth Law of Thermodynamics and its basis.

b. A reversible engine is supplied with heat from two constant temperature sources at 900 K and 600 K and rejects heat to a constant temperature sink at 300 K. The engine develops work equivalent to 90 kJ/s and rejects heat at the rate of 56 kJ/s. Estimate (1) Heat supplied by each source and (2) Thermal efficiency of the engine.

QUESTION 3

a. A fluid in a cylinder is at a pressure of 700 kN/m^2. It is expanded at constant pressure from a volume of 0.28 m^3 to a volume of 1.68 m^3. Determine the work done.

b. A copper vessel of mass 2kg contains 6kg of water. If the initial temperature of the vessel plus water is 293K and the final temperature is 90^{0}C, how much of heat is transferred to accomplish this change, assuming there is no heat loss?
(Specific heat of Copper = 390 J/kgK; Specific heat capacity of water at 20 ^{0}C = 4181.6 J/kgK and Specific heat capacity of water at 90 ^{0}C = 4204.8 J/kgK)

QUESTION 4

a. Show that the work done by the gas during the Polytropic expansion process is given by the expression:

$$\text{Work done} = \frac{P_1V_1 - P_2V_2}{n-1}$$

b. 0.014 m^3 gas at a pressure of 2070 kN/m^2 expand to a pressure of 207 kN/m^2 according to the law, $PV^{1.35} = C$. Determine the work done by the gas during the expansion.

QUESTION 5

a. Define the following processes in thermodynamics
i. Isothermal
ii. Isobaric
iii. Isochoric
iv. Adiabatic

b. Find the temperature, specific volume, internal energy and enthalpy of the following
i. dry saturated steam at 9.8 bar
ii. saturated steam at 3.65 bar
iii. superheated steam at 15 bar and 450 ^{0}C
iv. saturated steam at 7 bar

c. Find the enthalpy of superheated steam at 18.5 bar and 432 ^{0}C.

QUESTION 6

a. Determine the specific volume occupied by 1 kg of steam at a pressure of 0.85MN/m^{2}and having a dryness fraction of 0.97.

b. This is expanded adiabatically to a pressure of 0.17 MN/m^2, the law of expansion being $PV^{1.13} = C$. Determine: the final dryness fraction of the steam and the change of internal energy of the steam during the expansion.

Saturated Water and Steam

T [°C]	p_s [bar]	v_g [m³/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]
0.01	0.006112	206.1	0*	2500.8	2500.8	0†	9.155	9.155
1	0.006566	192.6	4.2	2498.3	2502.5	0.015	9.113	9.128
2	0.007054	179.9	8.4	2495.9	2504.3	0.031	9.071	9.102
3	0.007575	168.2	12.6	2493.6	2506.2	0.046	9.030	9.076
4	0.008129	157.3	16.8	2491.3	2508.1	0.061	8.989	9.050
5	0.008719	147.1	21.0	2488.9	2509.9	0.076	8.948	9.024
6	0.009346	137.8	25.2	2486.6	2511.8	0.091	8.908	8.999
7	0.01001	129.1	29.4	2484.3	2513.7	0.106	8.868	8.974
8	0.01072	121.0	33.6	2481.9	2515.5	0.121	8.828	8.949
9	0.01147	113.4	37.8	2479.6	2517.4	0.136	8.788	8.924
10	0.01227	106.4	42.0	2477.2	2519.2	0.151	8.749	8.900
11	0.01312	99.90	46.2	2474.9	2521.1	0.166	8.710	8.876
12	0.01401	93.83	50.4	2472.5	2522.9	0.180	8.671	8.851
13	0.01497	88.17	54.6	2470.2	2524.8	0.195	8.633	8.828
14	0.01597	82.89	58.8	2467.8	2526.6	0.210	8.594	8.804

Superheated Steam*

p/[bar] (T_s/[°C])		T [°C]	200	250	300	350	400	450	500	600
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
10 (179.9)	v_g 0.1944	v	0.2061	0.2328	0.2580	0.2825	0.3065	0.3303	0.3540	0.4010
	u_g 2584	u	2623	2711	2794	2875	2957	3040	3124	3297
	h_g 2778	h	2829	2944	3052	3158	3264	3370	3478	3698
	s_g 6.586	s	6.695	6.926	7.124	7.301	7.464	7.617	7.761	8.028
15 (198.3)	v_g 0.1317	v	0.1324	0.1520	0.1697	0.1865	0.2029	0.2191	0.2351	0.2667
	u_g 2595	u	2597	2697	2784	2868	2952	3035	3120	3294
	h_g 2792	h	2796	2925	3039	3148	3256	3364	3473	3694
	s_g 6.445	s	6.452	6.711	6.919	7.102	7.268	7.423	7.569	7.838
20 (212.4)	v_g 0.0996	v		0.1115	0.1255	0.1386	0.1511	0.1634	0.1756	0.1995
	u_g 2600	u		2681	2774	2861	2946	3030	3116	3291
	h_g 2799	h		2904	3025	3138	3248	3357	3467	3690
	s_g 6.340	s		6.547	6.768	6.957	7.126	7.283	7.431	7.701
30 (233.8)	v_g 0.0666	v		0.0706	0.0812	0.0905	0.0993	0.1078	0.1161	0.1324
	u_g 2603	u		2646	2751	2845	2933	3020	3108	3285
	h_g 2803	h		2858	2995	3117	3231	3343	3456	3682
	s_g 6.186	s		6.289	6.541	6.744	6.921	7.082	7.233	7.507
40 (250.3)	v_g 0.0498	v			0.0588	0.0664	0.0733	0.0800	0.0864	0.0988
	u_g 2602	u			2728	2828	2921	3010	3099	3279
	h_g 2801	h			2963	3094	3214	3330	3445	3674
	s_g 6.070	s			6.364	6.584	6.769	6.935	7.089	7.368