L-1/T-2/NAME **Date: 12/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

Sub: **ME 169** (Basic Thermal Engineering)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Write short notes on: **(20)**

(i) Process and Cycle, (ii) Quasi-equilibrium process and Adiabatic process, (iii) Point function and Path function, (iv) Thermodynamic system and Thermal equilibrium.

(b) "Work is a more valuable form of energy transfer than heat." – Explain. **(7)**

(c) Define the following terms: **(8)**

(i) Subcooled liquid, (ii) Quality, (iii) Critical point.

2. (a) Write down the steady state steady flow (SSSF) equation and simplify the equation for the following devices with schematic diagrams and proper assumptions: **(15)**

(i) Heat exchanger, (ii) Nozzle and Diffuser, (iii) Turbine.

(b) Steam at 0.6 MPa and 200°C enters an insulated nozzle with a velocity of 50 m/s. It leaves at a pressure of 0.15 MPa and a velocity of 600 m/s. Determine the final temperature if the steam is superheated in the final state and the quality if it is saturated. **(10)**

(c) Define specific heat. Show that, enthalpy is a thermodynamic property. **(10)**

3. (a) Define the following terms: **(9)**

(i) Wet-bulb temperature, (ii) Specific humidity, (iii) Relative humidity.

(b) A cylinder fitted with a piston has a volume of 0.1 m^3 and contains 0.5 kg of steam at 0.4 MPa. Heat is transferred to the steam until the temperature is 300°C, while the pressure remains constant. Determine the heat transfer and the work for this process. **(8)**

(c) Prove the Clausius inequality $\oint \frac{\delta Q}{T} \leq 0$. **(18)**

4. (a) State the 2nd law of thermodynamics. Prove that, violation of the Kelvin-Planck statement leads to the violation of the Clausius statement. **(15)**

(b) Write short notes on: **(10)**

(i) Perpetual motion machine (PMM), (ii) Entropy generation.

(c) A refrigerator maintains its freezer compartment at – 5°C when the air surrounding the refrigerator is at 22°C. The rate of heat transfer from the freezer compartment to the refrigerant is 8000 kJ/h and the power input required to operate the refrigerator is 3200 kJ/h. Determine the coefficient of performance of the refrigerator and compare with the coefficient of performance of a reversible refrigeration cycle operating between reservoirs at the same two temperatures. **(10)**

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What are the 7 basis of boiler classification? Mention 3 purposes of boiler and 2 primary requirements of a boiler. Define boiler accessories and mountings with one example in each case. **(15)**

   (b) What is an air-preheater? How does its degree of preheating depend? Distinguish between a "Recuperative" and a "Regenerative" type air-preheaters. **(10)**

   (c) What is a Bourdon's tube? Draw and label (do not describe) a Bourdon type pressure gauge. **(10)**

6. (a) Identify the 15 items of a boiler as labelled from (1) to (15) in the figure for Q. No. 6(a) (do not draw the figure). **(15)**

   (b) Distinguish between a "Steam stop valve" and a "Feed check valve". **(10)**

   (c) Fill in the blanks (do not write the whole sentence) from number (1) to (10); number (11) is shown as an example. [Answer (11) = furnace] **(10)**

   Babcock and Wilcox boilers are horizontal, _____(1) fired, _____(2) tube, _____(3) circulation type _____(4) boilers. In these boilers, _____(5) are provided across the _____(6) tubes to act as _____(7) to the flue gases and to provide them with gas passes. To maintain equal gas _____(8) throughout its travel, the _____(9) size of these passes tends to _____(10) from _____(11) to exit.

7. (a) Briefly describe the working principle of a 2-stroke cycle diesel engine. Also draw the actual indicator diagram and the valve timing diagram for the 2-stroke cycle diesel engine. **(15)**

   (b) A 4-cylinder car engine has its bore = 79 mm, stroke = 76.5 mm and clearance volume 41.6 cc. Find the total capacity of the car engine in cc and the engine's compression ratio. **(10)**

   (c) What do you mean by scavenging in IC Engine? Distinguish between scavenging processes of a 4-stroke engine with that of a 2-stroke engine. **(10)**

8. (a) Define a gas turbine and mention its 3 advantages over an IC Engine. What are the 2 modifications of the basic gas turbine cycle that increase the net work developed? Show the block diagram and T-s diagram of an ideal gas turbine with reheat. **(15)**

   (b) Briefly describe a combined cycle power plant with necessary diagrams. **(10)**

   (c) Despite the greater thermal efficiency of the Carnot cycle, why Rankine cycle is used? **(10)**

TABLE B.1.2
Saturated Water Pressure Entry

Press. (kPa)	Temp. (°C)	Specific Volume, m³/kg			Internal Energy, kJ/kg		
		Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Sat. Liquid u_f	Evap. u_{fg}	Sat. Vapor u_g
0.6113	0.01	0.001000	206.131	206.132	0	2375.3	2375.3
1	6.98	0.001000	129.20702	129.20802	29.29	2355.69	2384.98
1.5	13.03	0.001001	87.97913	87.98013	54.70	2338.63	2393.32
2	17.50	0.001001	67.00285	67.00385	73.47	2326.02	2399.48
2.5	21.08	0.001002	54.25285	54.25385	88.47	2315.93	2404.40
3	24.08	0.001003	45.66402	45.66502	101.03	2307.48	2408.51
4	28.96	0.001004	34.79915	34.80015	121.44	2293.73	2415.17
5	32.88	0.001005	28.19150	28.19251	137.79	2282.70	2420.49
7.5	40.29	0.001008	19.23674	19.23775	168.76	2261.74	2430.50
10	45.81	0.001010	14.67254	14.67355	191.79	2246.10	2437.89
15	53.97	0.001014	10.02117	10.02218	225.90	2222.83	2448.73
20	60.06	0.001017	7.64835	7.64937	251.35	2205.36	2456.71
25	64.97	0.001020	6.20322	6.20424	271.88	2191.21	2463.08
30	69.10	0.001022	5.22816	5.22918	289.18	2179.22	2468.40
40	75.87	0.001026	3.99243	3.99345	317.51	2159.49	2477.00
50	81.33	0.001030	3.23931	3.24034	340.42	2143.43	2483.85
75	91.77	0.001037	2.21607	2.21711	394.29	2112.39	2496.67
100	99.62	0.001043	1.69296	1.69400	417.33	2088.72	2506.06
125	105.99	0.001048	1.37385	1.37490	444.16	2069.32	2513.48
150	111.37	0.001053	1.15828	1.15933	466.92	2052.72	2519.64
175	116.06	0.001057	1.00257	1.00363	486.78	2038.12	2524.90
200	120.23	0.001061	0.88467	0.88573	504.47	2025.02	2529.49
225	124.00	0.001064	0.79219	0.79325	520.45	2013.10	2533.56
250	127.43	0.001067	0.71765	0.71871	535.08	2002.14	2537.21
275	130.60	0.001070	0.65624	0.65731	548.57	1991.95	2540.53
300	133.55	0.001073	0.60475	0.60582	561.13	1982.43	2543.55
325	136.30	0.001076	0.56093	0.56201	572.88	1973.46	2546.34
350	138.88	0.001079	0.52317	0.52425	583.93	1964.98	2548.92
375	141.32	0.001081	0.49029	0.49137	594.38	1956.93	2551.31
400	143.63	0.001084	0.46138	0.46246	604.29	1949.26	2553.55
450	147.93	0.001088	0.41289	0.41398	622.75	1934.87	2557.62
500	151.86	0.001093	0.37380	0.37489	639.66	1921.57	2561.23
550	155.48	0.001097	0.34159	0.34268	655.30	1909.17	2564.47
600	158.85	0.001101	0.31457	0.31567	669.88	1897.52	2567.40
650	162.01	0.001104	0.29158	0.29268	683.55	1886.51	2570.06
700	164.97	0.001108	0.27176	0.27286	696.43	1876.07	2572.49
750	167.77	0.001111	0.25449	0.25560	708.62	1866.11	2574.73
800	170.43	0.001115	0.23931	0.24043	720.20	1856.58	2576.79

TABLE B.1.2 (*continued*)
Saturated Water Pressure Entry

Press. (kPa)	Temp. (°C)	Enthalpy, kJ/kg			Entropy, kJ/kg-K		
		Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g
0.6113	0.01	0.00	2501.3	2501.3	0	9.1562	9.1562
1.0	6.98	29.29	2484.89	2514.18	0.1059	8.8697	8.9756
1.5	13.03	54.70	2470.59	2525.30	0.1956	8.6322	8.8278
2.0	17.50	73.47	2460.02	2533.49	0.2607	8.4629	8.7236
2.5	21.08	88.47	2451.56	2540.03	0.3120	8.3311	8.6431
3.0	24.08	101.03	2444.47	2545.50	0.3545	8.2231	8.5775
4.0	28.96	121.44	2432.93	2554.37	0.4226	8.0520	8.4746
5.0	32.88	137.79	2423.66	2561.45	0.4763	7.9187	8.3950
7.5	40.29	168.77	2406.02	2574.79	0.5763	7.6751	8.2514
10	45.81	191.81	2392.82	2584.63	0.6492	7.5010	8.1501
15	53.97	225.91	2373.14	2599.06	0.7548	7.2536	8.0084
20	60.06	251.38	2358.33	2609.70	0.8319	7.0766	7.9085
25	64.97	271.90	2346.29	2618.19	0.8930	6.9383	7.8313
30	69.10	289.21	2336.07	2625.28	0.9439	6.8247	7.7686
40	75.87	317.55	2319.19	2636.74	1.0258	6.6441	7.6700
50	81.33	340.47	2305.40	2645.87	1.0910	6.5029	7.5939
75	91.77	384.36	2278.59	2662.96	1.2129	6.2434	7.4563
100	99.62	417.44	2258.02	2675.46	1.3025	6.0568	7.3593
125	105.99	444.30	2241.05	2685.35	1.3739	5.9104	7.2843
150	111.37	467.08	2226.46	2693.54	1.4335	5.7897	7.2232
175	116.06	486.97	2213.57	2700.53	1.4848	5.6868	7.1717
200	120.23	504.68	2201.96	2706.63	1.5300	5.5970	7.1271
225	124.00	520.69	2191.35	2712.04	1.5705	5.5173	7.0878
250	127.43	535.34	2181.55	2716.89	1.6072	5.4455	7.0526
275	130.60	548.87	2172.42	2721.29	1.6407	5.3801	7.0208
300	133.55	561.45	2163.85	2725.30	1.6717	5.3201	6.9918
325	136.30	573.23	2155.76	2728.99	1.7005	5.2646	6.9651
350	138.88	584.31	2148.10	2732.40	1.7274	5.2130	6.9404
375	141.32	594.79	2140.79	2735.58	1.7527	5.1647	6.9174
400	143.63	604.73	2133.81	2738.53	1.7766	5.1193	6.8958
450	147.93	623.24	2120.67	2743.91	1.8206	5.0359	6.8565
500	151.86	640.21	2108.47	2748.67	1.8606	4.9606	6.8212
550	155.48	655.91	2097.04	2752.94	1.8972	4.8920	6.7892
600	158.85	670.54	2086.26	2756.80	1.9311	4.8289	6.7600
650	162.01	684.26	2076.04	2760.30	1.9627	4.7704	6.7330
700	164.97	697.20	2066.30	2763.50	1.9922	4.7158	6.7080
750	167.77	709.45	2056.98	2766.43	2.0199	4.6647	6.6846
800	170.43	721.10	2048.04	2769.13	2.0461	4.6166	6.6627

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TABLE B.1.3
Superheated Vapor Water

Temp. (°C)	v (m³/kg)	u (kJ/kg)	h (kJ/kg)	s (kJ/kg-K)	v (m³/kg)	u (kJ/kg)	h (kJ/kg)	s (kJ/kg-K)
	$P = 10$ kPa (45.81°C)				$P = 50$ kPa (81.33°C)			
Sat.	14.67355	2437.89	2584.63	8.1501	3.24034	2483.85	2645.87	7.5939
50	14.86920	2443.87	2592.56	8.1749	—	—	—	—
100	17.19561	2515.50	2687.46	8.4479	3.41833	2511.61	2682.52	7.6947
150	19.51251	2587.86	2782.99	8.6881	3.88937	2585.61	2780.08	7.9400
200	21.82507	2661.27	2879.52	8.9037	4.35595	2659.85	2877.64	8.1579
250	24.13559	2735.95	2977.31	9.1002	4.82045	2734.97	2975.99	8.3555
300	26.44508	2812.06	3076.51	9.2812	5.28391	2811.33	3075.52	8.5372
400	31.06252	2968.89	3279.51	9.6076	6.20929	2968.43	3278.89	8.8641
500	35.67896	3132.26	3489.05	9.8977	7.13364	3131.94	3488.62	9.1545
600	40.29488	3302.45	3705.40	10.1608	8.05748	3302.22	3705.10	9.4177
700	44.91052	3479.63	3928.73	10.4028	8.98104	3479.45	3928.51	9.6599
800	49.52599	3663.84	4159.10	10.6281	9.90444	3663.70	4158.92	9.8852
900	54.14137	3855.03	4396.44	10.8395	10.82773	3854.91	4396.30	10.0967
1000	58.75669	4053.01	4640.58	11.0392	11.75097	4052.91	4640.46	10.2964
1100	63.37198	4257.47	4891.19	11.2287	12.67418	4257.37	4891.08	10.4858
1200	67.98724	4467.91	5147.78	11.4090	13.59737	4467.82	5147.69	10.6662
1300	72.60250	4683.68	5409.70	14.5810	14.52054	4683.58	5409.61	10.8382
	100 kPa (99.62°C)				200 kPa (120.23°C)			
Sat.	1.69400	2506.06	2675.46	7.3593	0.88573	2529.49	2706.63	7.1271
150	1.93636	2582.75	2776.38	7.6133	0.95964	2576.87	2768.80	7.2795
200	2.17226	2658.05	2875.27	7.8342	1.08034	2654.39	2870.46	7.5066
250	2.40604	2733.73	2974.33	8.0332	1.19880	2731.22	2970.98	7.7085
300	2.63876	2810.41	3074.28	8.2157	1.31616	2808.55	3071.79	7.8926
400	3.10263	2967.85	3278.11	8.5434	1.54930	2966.69	3276.55	8.2217
500	3.56547	3131.54	3488.09	8.8341	1.78139	3130.75	3487.03	8.5132
600	4.02781	3301.94	3704.72	9.0975	2.01297	3301.36	3703.96	8.7769
700	4.48986	3479.24	3928.23	9.3398	2.24426	3478.81	3927.66	9.0194
800	4.95174	3663.53	4158.71	9.5652	2.47539	3663.19	4158.27	9.2450
900	5.41353	3854.77	4396.12	9.7767	2.70643	3854.49	4395.77	9.4565
1000	5.87526	4052.78	4640.31	9.9764	2.93740	4052.53	4640.01	9.6563
1100	6.33696	4257.25	4890.95	10.1658	3.16834	4257.01	4890.68	9.8458
1200	6.79863	4467.70	5147.56	10.3462	3.39927	4467.46	5147.32	10.0262
1300	7.26030	4683.47	5409.49	10.5182	3.63018	4683.23	5409.26	10.1982
	300 kPa (133.55°C)				400 kPa (143.63°C)			
Sat.	0.60582	2543.55	2725.30	6.9918	0.46246	2553.55	2738.53	6.8958
150	0.63388	2570.79	2760.95	7.0778	0.47084	2564.48	2752.82	6.9299
200	0.71629	2650.65	2865.54	7.3115	0.53422	2646.83	2860.51	7.1706

TABLE B.1.3 (*continued*)
Superheated Vapor Water

Temp. (°C)	v (m³/kg)	u (kJ/kg)	h (kJ/kg)	s (kJ/kg-K)	v (m³/kg)	u (kJ/kg)	h (kJ/kg)	s (kJ/kg-K)
	300 kPa (133.55°C)				400 kPa (143.63°C)			
250	0.79636	2728.69	2967.59	7.5165	0.59512	2726.11	2964.16	7.3788
300	0.87529	2806.69	3069.28	7.7022	0.65484	2804.81	3066.75	7.5661
400	1.03151	2965.53	3274.98	8.0329	0.77262	2964.36	3273.41	7.8984
500	1.18669	3129.95	3485.96	8.3250	0.88934	3129.15	3484.89	8.1912
600	1.34136	3300.79	3703.20	8.5892	1.00555	3300.22	3702.44	8.4557
700	1.49573	3478.38	3927.10	8.8319	1.12147	3477.95	3926.53	8.6987
800	1.64994	3662.85	4157.83	9.0575	1.23722	3662.51	4157.40	8.9244
900	1.80406	3854.20	4395.42	9.2691	1.35288	3853.91	4395.06	9.1361
1000	1.95812	4052.27	4639.71	9.4689	1.46847	4052.02	4639.41	9.3360
1100	2.11214	4256.77	4890.41	9.6585	1.58404	4256.53	4890.15	9.5255
1200	2.26614	4467.23	5147.07	9.8389	1.69958	4466.99	5146.83	9.7059
1300	2.42013	4682.99	5409.03	10.0109	1.81511	4682.75	5408.80	9.8780
	500 kPa (151.86°C)				600 kPa (158.85°C)			
Sat.	0.37489	2561.23	2748.67	6.8212	0.31567	2567.40	2756.80	6.7600
200	0.42492	2642.91	2855.37	7.0592	0.35202	2638.91	2850.12	6.9665
250	0.47436	2723.50	2960.68	7.2708	0.39383	2720.86	2957.16	7.1816
300	0.52256	2802.91	3064.20	7.4598	0.43437	2801.00	3061.63	7.3723
350	0.57012	2882.59	3167.65	7.6328	0.47424	2881.12	3165.66	7.5463
400	0.61728	2963.19	3271.83	7.7937	0.51372	2962.02	3270.25	7.7078
500	0.71093	3128.35	3483.82	8.0872	0.59199	3127.55	3482.75	8.0020
600	0.80406	3299.64	3701.67	8.3521	0.66974	3299.07	3700.91	8.2673
700	0.89691	3477.52	3925.97	8.5952	0.74720	3477.08	3925.41	8.5107
800	0.98959	3662.17	4156.96	8.8211	0.82450	3661.83	4156.52	8.7367
900	1.08217	3853.63	4394.71	9.0329	0.90169	3853.34	4394.36	8.9485
1000	1.17469	4051.76	4639.11	9.2328	0.97883	4051.51	4638.81	9.1484
1100	1.26718	4256.29	4889.88	9.4224	1.05594	4256.05	4889.61	9.3381
1200	1.35964	4466.76	5146.58	9.6028	1.13302	4466.52	5146.34	9.5185
1300	1.45210	4682.52	5408.57	9.7749	1.21009	4682.28	5408.34	9.6906
	800 kPa (170.43°C)				1000 kPa (179.91°C)			
Sat.	0.24043	2576.79	2769.13	6.6627	0.19444	2583.64	2778.08	6.5864
200	0.26080	2630.61	2839.25	6.8158	0.20596	2621.90	2827.86	6.6939
250	0.29314	2715.46	2949.97	7.0384	0.23268	2709.91	2942.59	6.9246
300	0.32411	2797.14	3056.43	7.2327	0.25794	2793.21	3051.15	7.1228
350	0.35439	2878.16	3161.68	7.4088	0.28247	2875.18	3157.65	7.3010
400	0.38426	2959.66	3267.07	7.5715	0.30659	2957.29	3263.88	7.4650
500	0.44331	3125.95	3480.60	7.8672	0.35411	3124.34	3478.44	7.7621
600	0.50184	3297.91	3699.38	8.1332	0.40109	3296.76	3697.85	8.0289

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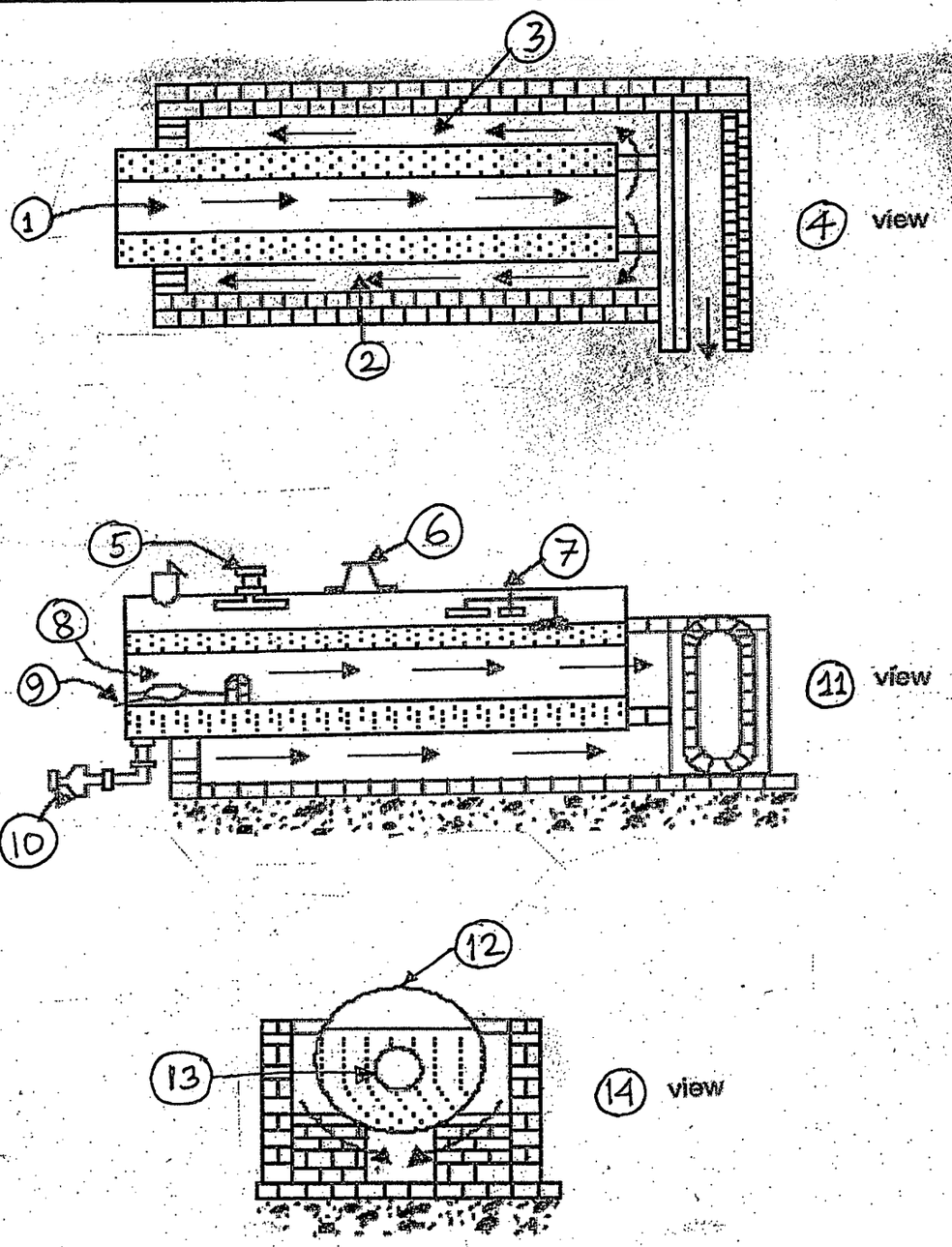


Fig. (15) boiler

figure for Question number 6 (a)

L-1/T-2/NAME **Date : 18/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-/1T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **MATH 183** (Coordinate Geometry and Ordinary Differential Equations)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Transform the equation $x^2 - y^2 - 2ax + 2by + c^2 = 0$ to rectangular axes through the point (a, b) inclined at an angle $\frac{\pi}{4}$ to the original axes. **(18)**

(b) Prove that the straight line represented by the equation

$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ will be equidistant from the origin if

$f^4 - g^4 = c(bf^2 - ag^2)$ **(17)**

2. (a) Show that the necessary and sufficient condition that two of the lines represented by the equation $ax^4 + by^3x + cx^2y^2 + dxy^3 + ey^4 = 0$ should be at right angles is $(b+d)(ad+be)+(e-a)^2(a+c+e)=0.$ **(18)**

(b) Find the equation of pair of tangents drawn from the origin to the circle $x^2 + y^2 + 2gx + 2fy + c = 0.$ **(17)**

3. (a) Find the equation of the circle passing through the origin and coaxial with the circles $x^2 + y^2 - 6x + 4y - 8 = 0$ and $x^2 + y^2 + 2x + y + 4 = 0.$ **(17)**

(b) Obtain the equation of the asymptotes of the hyperbola $2xy + 3x^2 + 4x - 9 = 0$. Also find the equation of the conjugate hyperbola. **(18)**

4. (a) Find the locus of the middle point of chords of the parabola $y^2 = 4ax$ which subtends a right angle at the vertex. **(18)**

(b) Show that the tangents to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ at the ends of a chord which subtends a right angle at the centre intersect on the ellipse $\frac{x^2}{a^4} + \frac{y^2}{b^4} = \frac{1}{a^2} + \frac{1}{b^2}$. **(17)**

Contd P/2

MATH 183(NAME)

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

Symbols have their usual meaning

5. (a) Form a differential equation by eliminating the constants A and B from the equation

$y = e^{mx}(A\cos nx + B\sin nx)$. **(15)**

(b) Solve the following: (i) $\frac{dy}{dx} = \frac{x+2y-3}{2x+y-3}$, (ii) $\frac{dy}{dx} = \sin(x+y) + \cos(x+y)$ **(20)**

6. (a) Determine whether the differential equation

$(x - y^3 + y^2\sin x)dx = (3xy^2 + 2y\cos x)dy$ is exact. If it is exact, solve it. **(15)**

(b) Find the integrating factor and hence solve: **(10)**

$(xy\sin xy + \cos xy)ydx + (xy\sin xy - \cos xy)xdy = 0$

(c) Solve: $\frac{dy}{dx} - \frac{\tan y}{1+x} = (1+x)e^x \sec y$. **(10)**

7. (a) Solve the following differential equation by using variation of parameters

$y'' + y = \sec x$. **(13)**

(b) Solve: $\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = xe^x \sin x$. **(12)**

(c) Solve the following Cauchy-Euler equation by converting the differential equation to constant coefficients: $x^2y'' - 4xy' + 6y = \ln x^2$. **(10)**

8. (a) Solve the following differential equations: **(10+10)**

(i) $y\frac{d^2y}{dx^2} - \left(\frac{dy}{dx}\right)^2 = y^2 \ln y$.

(ii) $\frac{d^2y}{dx^2} + \frac{dy}{dx} + \left(\frac{dy}{dx}\right)^3 = 0$.

(b) Solve: $(xp + y)^2 = xy$. **(15)**

L-1/T-2/NAME **Date : 24/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **EEE 161** (Electrical Engineering Principles)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Solve for $v_0(t)$ in the circuit given in Fig. for Q. 1(a) using the superposition principle. **(20)**

   (b) Find the value of resistnace R for the circuit given in Fig. for Q. 1(b) so that maximum power is transferred to that resistance. Compute the maximum power as well. **(15)**

2. (a) Compute the value of the capacitor C in the circuit given in Fig. for Q. 2(a) so that the phase of the current *I* is zero. The frequency of the voltage source is 60 *Hz*. Also, find the power consumed by the circuit. **(15)**

   (b) A single phase 15 KVA, 2300/230-V transformer is to be tested to determine its excitation branch components, its series impedances, and its voltage regulation. The following test data has been taken from the primary side of the transformer: **(20)**

Open Circuit Test	Short Circuit Test
$V_{OC} = 2300\ V$	$V_{SC} = 47\ V$
$I_{OC} = 0.21\ A$	$I_{SC} = 6\ A$
$P_{OC} = 50\ W$	$P_{SC} = 160\ W$

   (i) Find the equivalent circuit of the transformer referred to the high voltage side.

   (ii) Calculate the full load voltage regulation at 0.8 lagging power factor.

   (iii) What is the efficiency of the transformer with full-load at 0.8 power factor lagging.?

3. (a) How is speed controlled in DC motors by varying field resistance and armature voltage? **(10)**

   (b) Derive the terminal characteristic of a series DC motor are given below: **(10)**

Contd P/2

EEE 161/NAME

Contd ... Q. No 3

(c) The parameters of a shunt-connected DC motor. **(15)**

P_{rated} = 15 *hp*, $I_{L,rated}$ = 55A, V_T = 240 V,

N_{rated} = 1200 rpm, R_A = 0.40 Ω, R_F = 100 Ω R_{adj} = 100 to 400 Ω Rotational Losses are 1800 W at full load. The magnetization curve is shown in Fig. for Q. 3(c) Assume no armature reaction.

(i) If the resistor R_{adj} is adjusted to 175 Ω, what is the rotational speed of the motor at no load condition?

(ii) What is the full load speed of the motor at this condition?

(iii) What is the speed regulation?

(iv) What are the maximum and minimum no-load speeds of the motor?

4. (a) Derive the terminal characteristics of a shunt DC Generator. How is voltage built up in a shunt DC generator? **(15)**

(b) The magnetizing curve for a separately excited DC generator is shown in Fig. for Q. 4(b)(-i). The generator is rated at 6 KW, 120 V, 50 A and 1800 rpm and its parameters are given in the circuit shown in Fig. for Q. 4(b)-(ii). The field current is 5 A. **(20)**

(i) If the generator is operating at no load, what is the range of voltage adjustments, that can be achieved by changing Radj?

(ii) If the armature current in the generator is 50 A, the speed of the generator is 1700 rpm, and the terminal voltage V_T is 106 V, how much field current, I_F must be flowing through the generator?

(iii) If the generator is reconnected as a shunt DC generator, what would be terminal voltage of the generator?

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Find i_o in the circuit of Fig. for 5(a) using Superposition theorem. **(20)**

(b) The voltage and current were measured at the terminals of a device and the results are tabulated as shown in Fig. for 5(b). **(15)**

EEE 161/NAME

Contd ... Q. No 5(b)

(i) Sketch the $v_t - i_t$ characteristics of the device.

(ii) Construct a circuit model for this device using an ideal current source in parallel with a resister.

(iii) Use the model to predict the amount of power, the device will deliver to a 20 Ω resistive load.

6. (a) The circuit shown in Fig. for 6(a) is two-way power divider circuit. Find the equivalent resistance R_{ab} with respect to the nodes 'a' and 'b' and also determine the value of voltage V_0, **(10)**

(b) Use Mesh analysis to find the five branch currents $i_a - i_e$ for the circuit shown in Fig. for 6(b) **(25)**

7. (a) For the circuit in Fig. for Q. 7(a), what should be the value of the resistor R_0 so that 200 W power is dissipated in the resistor? **(20)**

(b) Refer to the circuit in Fig. for 7(b). **(15)**

(i) Use nodal analysis to find v_0 in the circuit.

(ii) Find the power absorbed by the dependent source.

(iii) Find the total power delivered by the independent sources.

8. A balanced, three-phase Δ-connected source is shown in Fig. for 8. **(11+12+12=35)**

(i) Find the Y-connected equivalent circuit

(ii) Show that the Y-connected equivalent circuit delivers the same open-circuit voltage as the original Δ-connected source.

(ii) Apply an external short circuit to the terminals A, B, C and find the three line currents $\mathbf{I_{aA}}$, $\mathbf{I_{bB}}$, $\mathbf{I_{cC}}$.

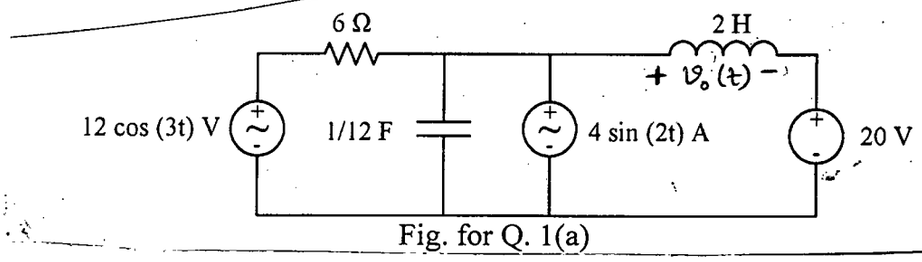


Fig. for Q. 1(a)

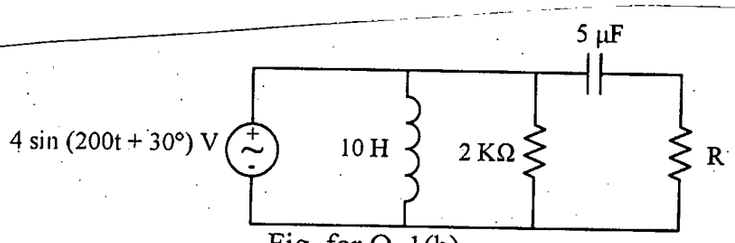


Fig. for Q. 1(b)

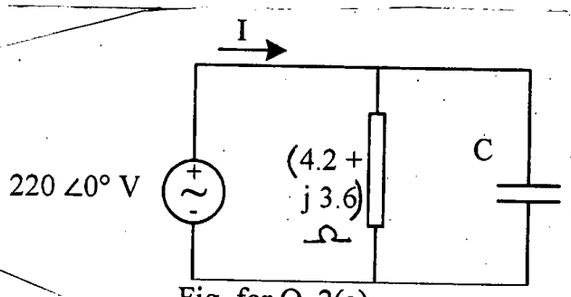


Fig. for Q. 2(a)

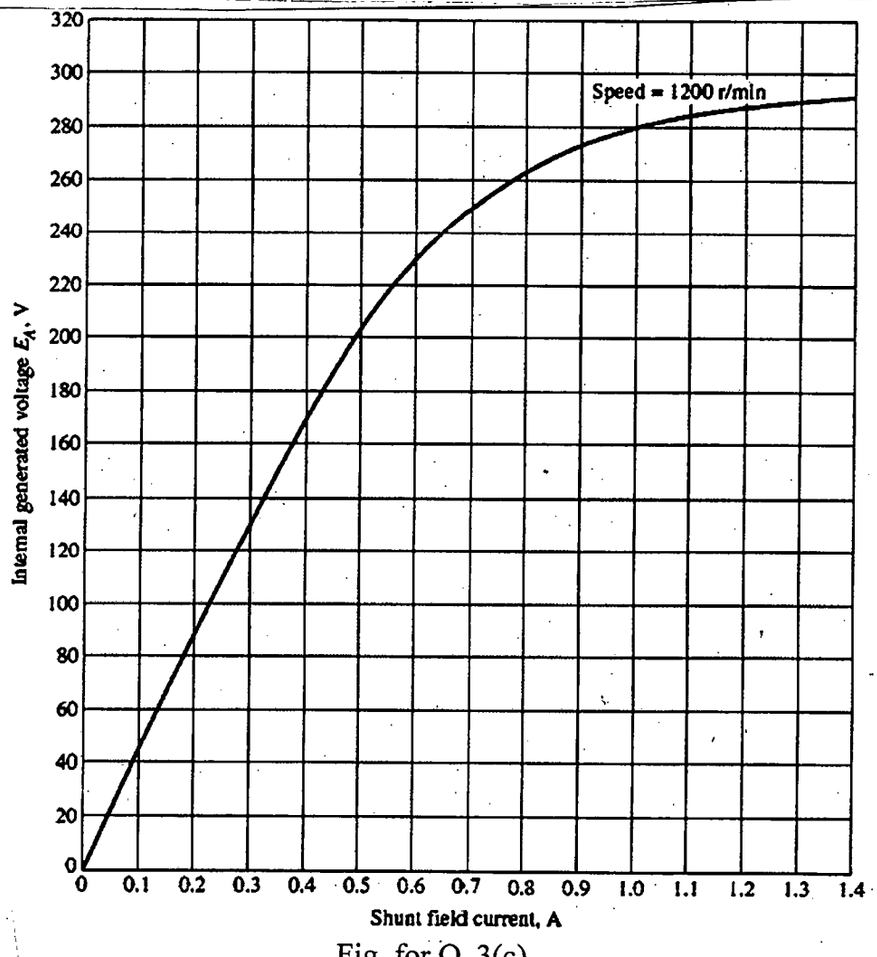


Fig. for Q. 3(c)

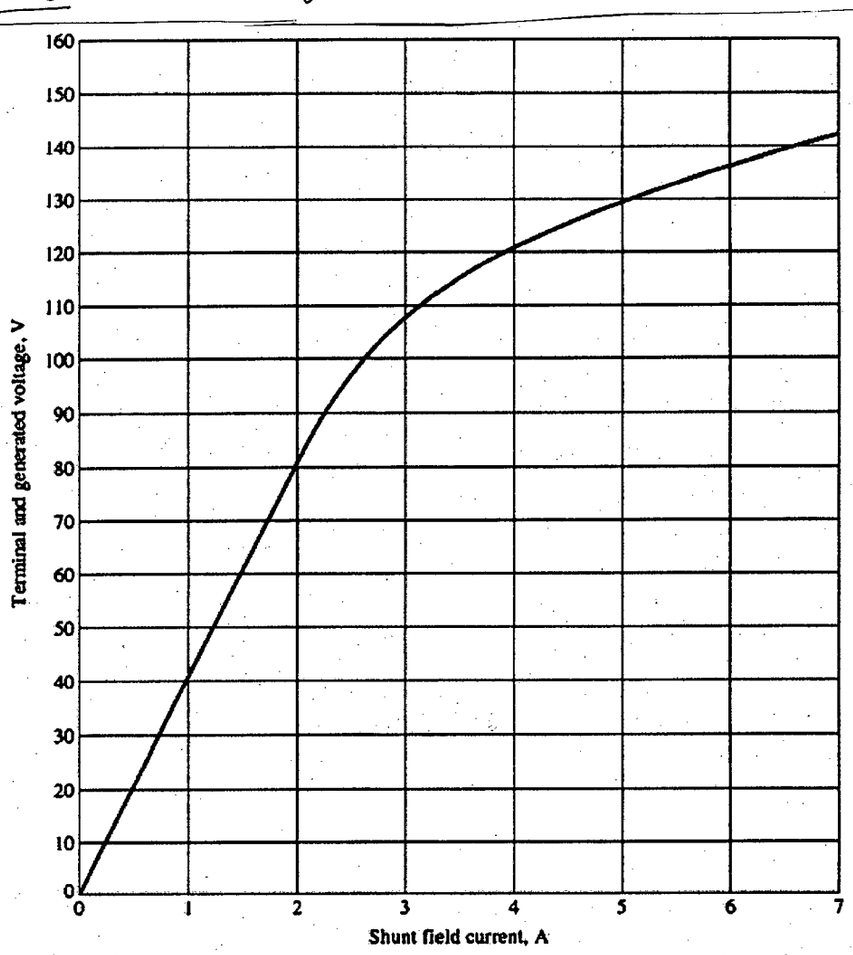


Fig. for Q. 4(b)-(i)

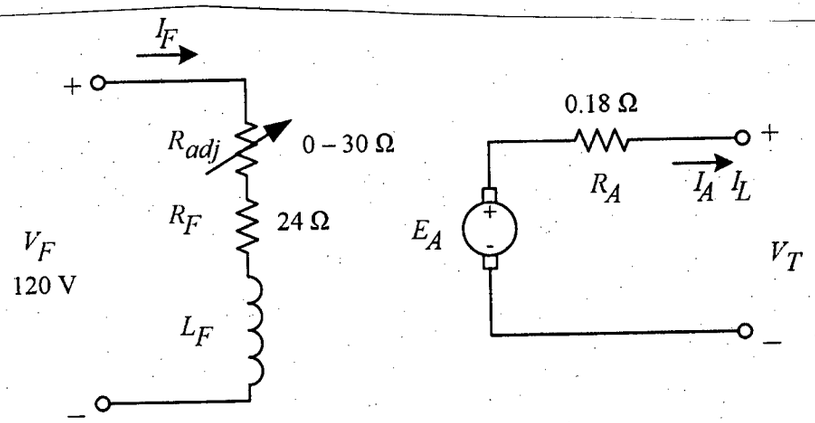


Fig. for Q. 4(b)-(ii)

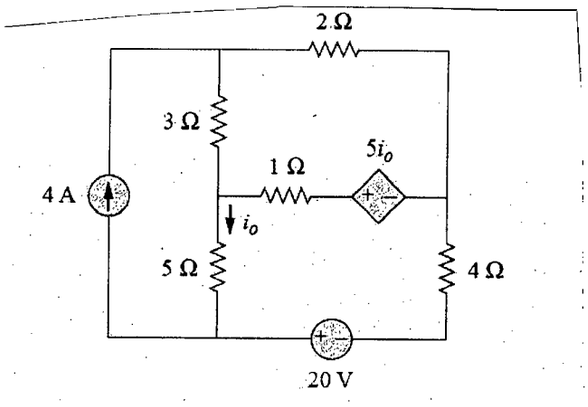
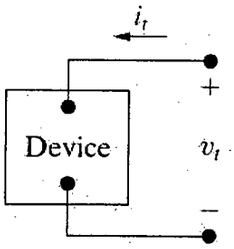


Fig. for 5(a)



v_t (V)	i_t (A)
100	0
120	4
140	8
160	12
180	16

Fig. for 5(b)

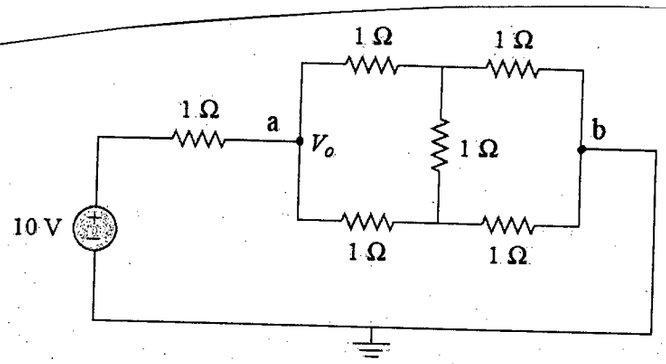


Fig. for 6(a)

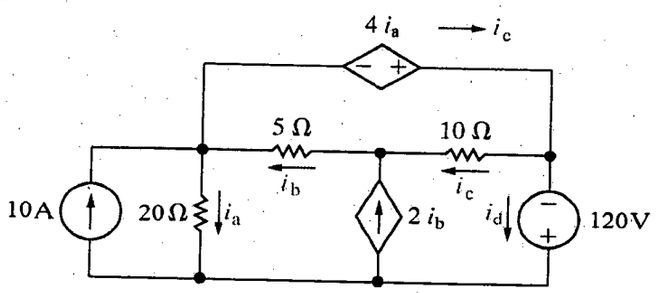


Fig. for 6(b)

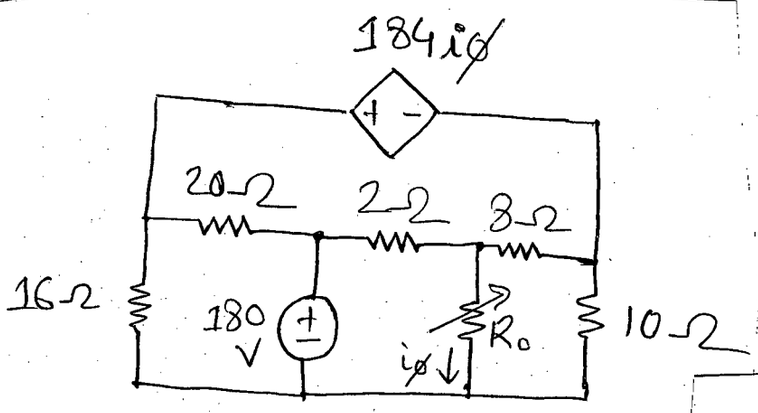


Fig for 7(a)

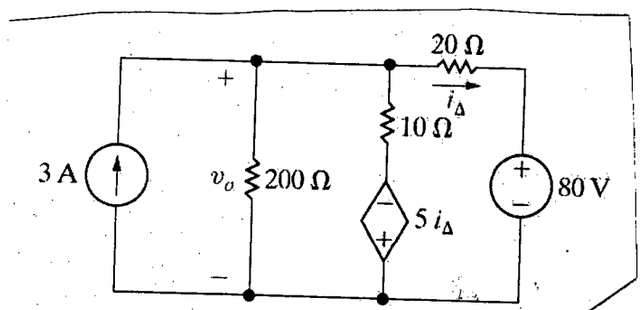


Fig. for 7(b)

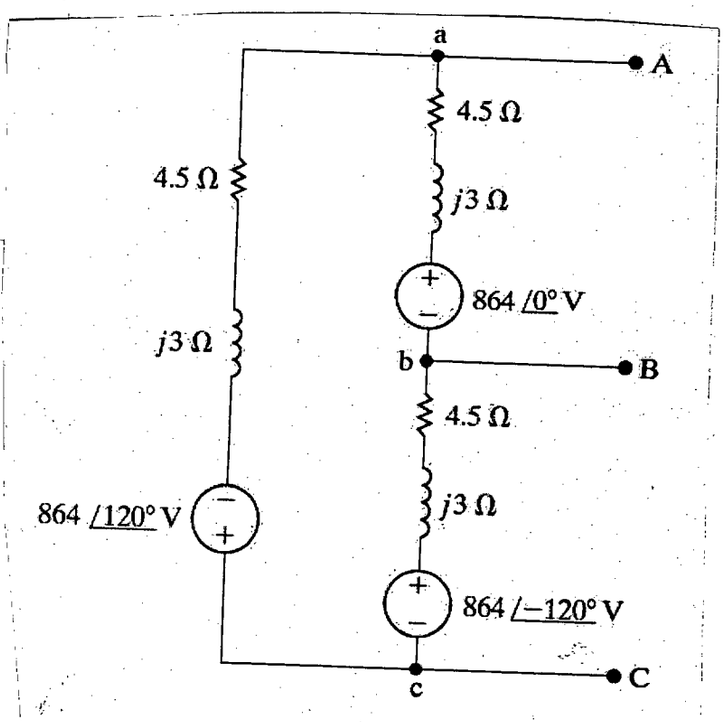


Fig. for 8

L-1/T-2/NAME **Date : 28/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **PHY 161** (Waves and Oscillation, Geometrical Optics and Wave Mechanics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Write down the required characteristics of wave function Ψ. An eigen function of the operator d^2/dx^2 is $\Psi = e^{2x}$. Find the corresponding eigen value. **(10)**

   (b) Write down the time independent and time dependent forms of Schrödinger wave equation. Draw schematically the wave function Ψ and the probability function $\Psi^*\Psi$ for an electron in a potential well for different n-values. What conclusions can be drawn from these schematic diagrams? **(15)**

   (c) Derive the infinite square well energy quantization law, directly from the de Broglie relation $p = h/\lambda$, by fitting an integral number of half de Broglie wavelengths $\lambda/2$ into the width 'a' of the well. **(10)**

2. (a) Consider a particle of mass m which can move freely along the x axis anywhere from $x = -a/2$ to $x = +a/2$, but which is strictly prohibited from being found outside this region. The particle bounces back and forth between the walls at $x = \pm a/2$ of a (one dimensional) box. The walls are assumed to be completely impenetrable, no matter how energetic is the particle. The wave function for the lowest energy state of the particle is

$$\Psi(x,t) = \begin{cases} A\cos\dfrac{\pi x}{a} e^{-iEt/h} & -a/2 < x < +a/2 \\ 0 & x \le -a/2 \quad or \quad x \ge +a/2 \end{cases}$$

   where A is an arbitrary real constant, and E is the total energy of the particle. Determine the value of E for this lowest energy state correspond to that wave function. **(13)**

   (b) The wave functions Ψ (x, t) for the lowest energy state of a simple harmonic oscillator consisting of a particle of mass m acted on by a linear restoring force of force constant C can be expressed as

$$\Psi(x,t) = Ae^{-\left(\sqrt{Cm}/2h\right)x^2} e^{-(i/2)\sqrt{C/m}t}$$

Contd P/2

PHY 161/NAME

Contd ... Q. No. 2(b)

where the real constant A can have any value. Verity that this expression is a solution of the Schrödinger equation for the appropriate potential. **(10)**

(c) Explain 'Quantum Mechanical Tunneling' effect and write down its important applications. **(12)**

3. (a) Define the term root mean square (rms) speed. Find the rms speed of oxygen molecules at 0°C. Draw also schematically the distributions of molecular speeds in Oxygen at 73 K and 273 K. **(12)**

(b) Write down the mathematical expressions for Fermi Dirac and Bose-Einstein's distribution functions. Distinguish between Fermion and Boson. **(13)**

(c) What is Fermi energy? Find the Fermi energy in copper on the assumption that each copper atom contributes one free electron to the electron gas. The density of copper is 8.94×10^3 kg/m^{3}and its atomic mass is 63.5 u. **(10)**

4. (a) Describe with suitable diagrams two aberrations of optical images formed by ordinary lenses (i) Coma and, (ii) Astigmatism. **(10)**

(b) What is meant by achromatism? Show that achromatism cannot be achieved by taking two lenses of the same material in contact. **(15)**

(c) The focal length of an achromatic combination of two lenses in contact is 90 cm. If the dispersive power of the materials of two lenses are 0.024 and 0.036. Calculate the focal lengths of the two lenses. **(10)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Discuss with suitable diagram the cardinal points for a thick lens. **(10)**

(b) Show that (i) the distance between the nodal points is equal to the distance between the principal points and, (ii) the principal points and the nodal points coincide with one another when the thick lens has the same medium on both sides. **(18)**

(b) Two thin convex lenses of focal lengths 6 cm and 2 cm are coaxial and separated by a distance of 4 cm. Calculate the power of the combination. **(7)**

Contd P/3

PHY 161/NAME

6. (a) What do you understand by visual angle and angular magnification? **(7)**

   (b) What is a simple microscope? Explain its action with a ray diagram and obtain an expression for its magnification. **(18)**

   (c) The ratio of the magnifying power of a convex lens when the image is formed at the least distance of distinct vision to that when the image is formed at infinity is 1.20. If the focal length of the lens is 4.80 cm, calculate (i) the least distance of distinct vision of the eye and, (ii) the distance from the lens where an object must be placed so as to form its image at the least distance of distinct vision. **(10)**

7. (a) What is a compound pendulum? Find an expression for the time period of a compound pendulum and show that there are four points collinear with the center of gravity, the periods of oscillation about which are equal. **(3+14+10)**

   (b) A body of mass 0.5 kg is suspended at a distance of 40 cm from its center of gravity. The moment of inertia about the axis of suspension is 0.14 kg-m^2. Find (i) Equivalent length of the compound pendulum (ii) Radius of gyration of the body. **(8)**

8. (a) Define Reverberation. State the assumptions of Sabine for a closed room and show that the growth of intensity of sound in a room is exponential. Deduce an expression for reverberation time. **(2+12+12)**

   (b) A room has dimension 6 × 4 × 5 m3 contains rock wood and designed so that the absorbing surface can be varied to maintain the total absorption (i) By what amount must the area of the wood be increased to compensate exactly for departure of 80 people (ii) Calculate the number of reflections/sec of the sound wave with the walls of the room. Velocity of sound = 350 m/s, absorption coefficient of rock wood = 0.63 and absorbing power of a man = 0.5 Sabine. **(9)**

L-1/T-2/NAME **Date : 06/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **NAME 123** (Fluid Mechanics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Assume reasonable value for any missing data. Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Derive the Reynolds transport theorem for an arbitrary fixed control volume. Use your derivation to obtain the integral forms of linear momentum equation, and energy equation. Explain how you have to modify the Reynolds transport theorem derived for a fixed control volume if the control volume is (i) moving at constant velocity (ii) arbitrarily moving and deformable. **(25)**

   (b) Water flows through the duct in Figure for Q. No. 1(b), which is 50 cm wide and 1 m deep into the paper. Gate BC completely closes the duct when $\beta = 90°$. Assuming one-dimensional flow, for what angle β will be the force of the exit jet on the plot be 3 kN? **(10)**

2. (a) Consider a steady, incompressible, two-dimensional laminar flow between two stationary parallel plates as shown in Figure for Q. No. 2(a). For a constant property fluid with a fully developed flow, determine the velocity profile subject to the boundary conditions when the vertical component of flow velocity is zero everywhere. Also prove that pressure varies hydrostatically in the y-direction. **(20)**

   (b) A conical pipe 10 cm inlet diameter, 20 cm outlet diameter and 100 cm long is placed horizontally. The velocity over any cross-section may be considered to be uniform. Determine the convective and local acceleration at a section where the diameter is 15 cm for the following two cases: **(15)**

   (i) constant inlet discharge 0.2 m^3/s

   (ii) Inlet discharge varying linearly from 0.2 m^3/s to 0.4 m^3/s over two seconds. The time of interest is when t = 1 second.

Contd P/2

NAME 123

3. (a) A horizontal flat plate is exposed to a stream of viscous fluid flowing parallel to the plates with velocity, $\bar{V} = U_0\hat{\imath}$. The length of the plate is L and width is b. Using an integral analysis, prove that the drag force D on one side of the plate is given by:

$$D(x) = \rho b \int_0^{\delta(x)} u(U_0 - u)dy$$

Hence using Karman's analysis of flat plate, obtain an approximate expression for laminar boundary layer thickness. **(25)**

(b) An oil with ρ = 900 kg/m^3 and v = 0.0002 m^2/S flows upwards through an inclined pipe as shown in Figure for Q. No. 3(b). The pressure and elevation are known at section 1 and 2, 10 m apart. Assuming steady laminar flow, verify that the flow is up. Also compute the head loss between 1 and 2, and calculate the volume flow rate. **(10)**

4. (a) Derive the Euler's Equation of motion for two-dimensional inviscid steady flow. **(15)**

(b) Derive the Bernoulli equation from steady flow energy equation. State how you may obtain the Bernoulli equation from the Euler's equation. Explain why the Bernoulli equation follows either from the law of motion (Euler's equation) or from the first law of thermodynamics (energy equation) **(20)**

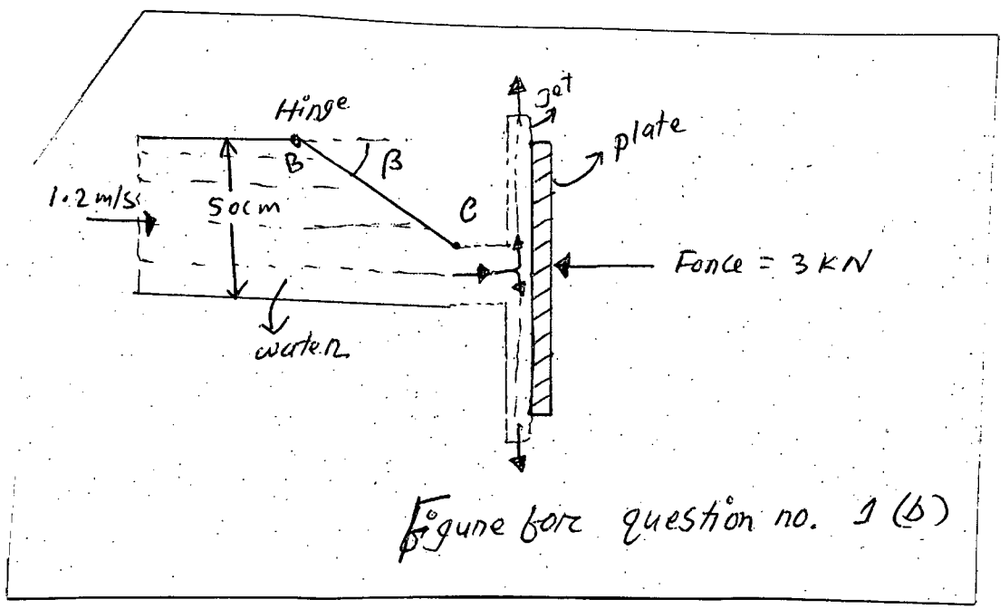


Figure for question no. 3 (b)

NAME 123

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define and explain Froude Number, Euler Number and Mach Number with their significances. **(15)**

   (b) The force F required to drive a propeller in water depends on diameter of propeller D, speed of advance V, density of water ρ, speed of rotation of propeller N and viscosity of water μ. Show that the relation between F and the variable is given by. **(20)**

$$F = \rho V^2 D^2 f\left(\frac{\rho VD}{\mu}, \frac{V}{DN}\right)$$

6. (a) Explain different types of similitude. A 1:60 Model of a boat has a wave resistance of 0.36 N when operating at a velocity of 1.25 m/s. Find the corresponding prototype wave resistance. Also find the power requirement for the prototype and model. **(20)**

   (b) Explain capillarity with figure. What is surface tension? Calculate the distance h for mercury in the capillary glass tube of 3.50 mm diameter. The angle of contact is equal to 130°. The surface tension of mercury in contact with air is 0.51 N/m. **(15)**

7. (a) Distinguish between streamline, pathline and streakline. Write down the characteristics of streamline. **(15)**

   (b) Derive the continuity equation for three dimensional incompressible flow. Water flows through a 4.0 cm diameter pipe at 5 cm/s. The pipe narrows downstream and has a diameter of 2.0 cm. What is the velocity of the water through the smaller pipe? **(20)**

8. (a) Write short note on Saybolt viscometer with figure. A vertical shaft, 120 mm in diameter, is rotating with 250 rpm. The shaft passes through a sleeve of length 150 mm which is stationary. The radial clearance between the shaft and sleeve is 0.1 mm and the space between them contains oil of dynamic viscosity 0.2 poise. Assuming a linear velocity distribution, determine the torque and power necessary to rotate the shaft. **(15)**

   (b) Define manometer. What are the standard atmospheric conditions? Pressures in the pipes A and B are 280 kPa and 140 kPa respectively. Find the deflection of the mercury in the differential manometer shown in Figure for Q. No. 4(b). Specific gravity of mercury is 13.6. **(20)**

Contd... P/4

NAME 123 =4=

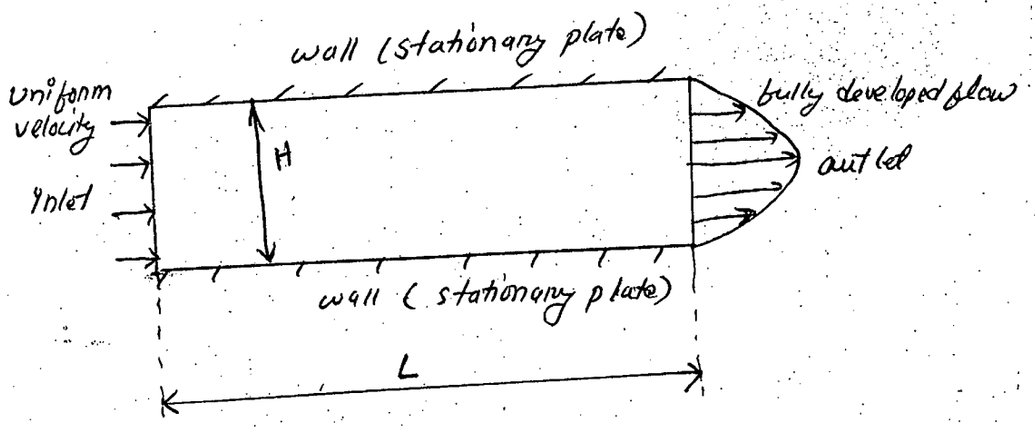
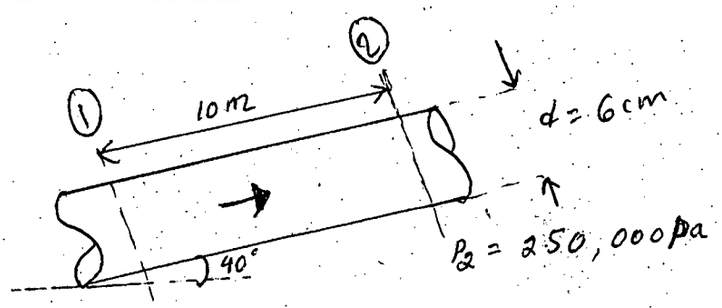


Figure for question no. 2 (a)



P_1 = 350,000 Pa, z_1 = 0

Figure for question no. 3 (b)

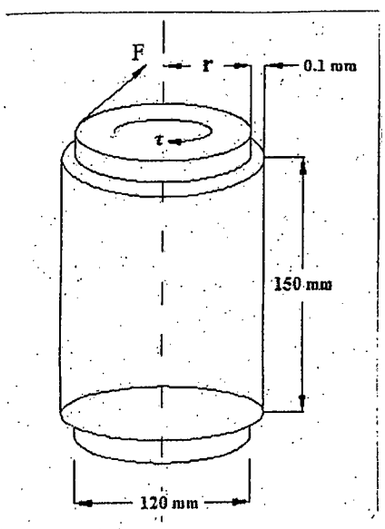


Figure for Q. No. 8(a)

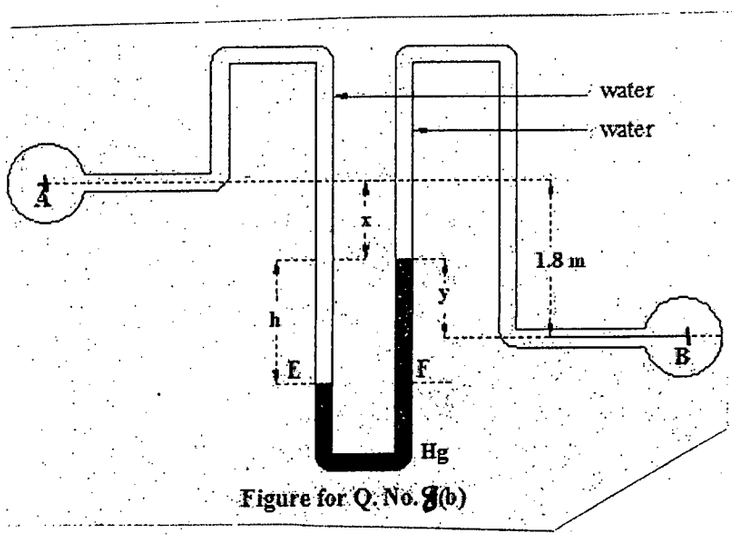


Figure for Q. No. 8(b)

X