L-1/T-2/NAME

Date : 31/03/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2017-2018

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

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) Establish the differential equation of simple harmonic motion. **(6)**

(b) What is a torsional pendulum? Show that for a small angular displacement the oscillation of a torsional pendulum is simple harmonic motion. Obtain an expression for the period of oscillation. **(5+12+5)**

(c) The displacement of an oscillating particle at any instant t is given by y = a cos ωt + b sin ωt. Show that it is executing simple harmonic motion. If a = 5 cm, b = 12 cm and ω = 4 radians/sec, calculate its (i) amplitude, (ii) time period, (iii) maximum velocity and (iv) maximum acceleration. **(7)**

2. (a) What are Lissajous' figures? Obtain the general expression for the resultant vibration of a particle simultaneously acted upon by two perpendicular simple harmonic vibrations, having the same frequency but different amplitudes and phase angles. Discuss the formation of Lissajous' figures when the phase difference is zero and π/2. **(5+15+5)**

(b) Two simple harmonic motions acting simultaneously on a particle are given by the equations **(10)**

$y_1 = \sin(\omega t + \pi/3)$

$y_2 = 2\sin \omega t$.

Calculate (i) amplitude, (ii) phase constant and (iii) time period of the resultant vibration. What is the equation of the resultant vibration?

3. (a) What do you mean by group velocity and phase velocity. Establish the relation between phase velocity and group velocity. Discuss their relation in dispersive and non-dispersive mediums. **(5+7+5)**

(b) Derive the differential equation of one-dimensional progressive wave. **(8)**

(c) Which of the followings are solutions of the one-dimensional wave equation? **(10)**

(i) $y = x^2 + v^2t^2$

(ii) $y = \sin 2x \cos vt$.

4. (a) Explain the statement "Statistical mechanics are not concerned with calculating the exact outcome of single isolated events but rather predicting the average outcome of many cooperative events". **(5)**

(b) Derive the Maxwell-Boltzmann distribution law for a system of particles. **(22)**

(c) Consider a system of n number of particles. Calculate the average energy of an isolated system in terms of absolute temperature and partition function. **(8)**

Contd P/2

SECTION - B

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

5. (a) What are Bosons and Fermions? **(5)**

(b) A one dimensional simple harmonic oscillator is in equilibrium with a heat reservoir at absolute temperature T. Deduce an expression for the partition function of the system. Hence find out the expression of mean energy. **(22)**

(c) Using the expression obtained in 5(b), what will be the values of average energy in the limiting cases of high and low temperatures? Are they in agreement with classical theory? **(8)**

6. (a) Write down the postulates of quantum mechanics. **(5)**

(b) Calculate the wave function and energy eigen value of a particle trapped in a one dimensional box of length, a. The potential is given by **(22)**

$$
\begin{aligned}
V(x) &= 0 \quad 0 \le x \le a \\
&= \infty \quad x < 0, x > a
\end{aligned}
$$

Discuss the physical significance of your results.

(c) Find the probability that a particle trapped in a box of length 'a' can be found between 0.4a and 0.5a for the ground and first excited state. **(8)**

7. (a) What is aberration? Describe with suitable diagrams two defects of optical images of an ordinary lens (i) Spherical aberration and (ii) Astigmatism. **(16)**

(b) Derive a condition for minimum spherical aberration by using two convergent lenses separated by a fixed distance. **(10)**

(c) It is desired to make an achromatic combination of focal length 20 cm by using two lenses of materials A and B. If the dispersive powers of A and B are in the ratio of 2:3, find the focal length of each lens. **(9)**

8. (a) Deduce the $\omega = \frac{d\mu}{\mu - 1}$, where the symbols indicate their usual meaning. **(5)**

(b) What is a compound microscope? Explain its action with a ray diagram and obtain an expression for its magnification. **(20)**

(c) Two lenses of focal lengths 1 cm and 5 cm are arranged as objective and eyepiece in a compound microscope and a small object is placed 1.1 cm in front of the objective. The final image is formed at a distance of 25 cm from the eyepiece. Find the resultant magnification and the separation between the lenses. **(10)**

L-1/T-2/NAME **Date : 06/04/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2017-2018

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

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**.

Psychrometric chart and necessary thermodynamic property tables have been supplied.

Assume reasonable value for any missing data.

1. (a) Write short notes on: **(15)**

   (i) Intensive property and Extensive property

   (ii) Isolated system and Open system

   (iii) Point function and Path function

   (b) State and explain the Zero'th law of thermodynamic with proper examples. **(10)**

   (c) Define the following terms with appropriate examples: **(10)**

   (i) Pure substance (ii) Compressed liquid (iii) Quality (iv) Allotropic transformation

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

   (i) Throttling process

   (ii) Turbine

   (iii) Nozzle and diffuser

   (b) A vessel having a volume of 5 m^3 contains 0.05 m^3 of saturated liquid water and 4.95 m^3 of saturated water vapor at 0.1 MPa. Heat is transferred until the vessel is filled with saturated vapor. Determine the heat transfer for this process. **(10)**

   (c) 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)**

3. (a) Consider a room that contains air at 1 atm, 35 °C, and 40% relative humidity. Using the psychrometric chart, determine the following: **(10)**

   (i) the specific humidity, (ii) the enthalpy, (iii) the wet-bulb temperature, (iv) the dew-point temperature, and (iv) the specific volume of the air.

   (b) Why compounding is done in impulse turbine? Draw the pressure and velocity profiles along the turbine axis from entrance to exit of the steam for- **(8)**

   (i) Pressure compounded impulse turbine

   (ii) Velocity compounded impulse turbine

Contd P/2

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Contd... Q. No. 3

(c) Prove that whenever a system undergoes a cycle, $\oint \frac{\delta Q}{T}$ is zero if the cycle is reversible and negative if irreversible. **(17)**

4. (a) With proper example and explanations prove that "It is impossible to construct an engine operating between only two heat reservoirs which will have a higher efficiency than a reversible engine operating between the same two reservoirs." **(12)**

(b) Can a refrigerator be operated as a heat pump? Justify your answer. **(7)**

(c) An inventor claims to have developed a heat engine that receives 650 kJ of heat from a source at 510 K and produces 290 kJ of net work while rejecting the waste heat to a sink at 300 K. Is this a reasonable claim? Why? **(8)**

(d) Prove that the coefficient of performance of a heat pump is greater than the coefficient of performance of a refrigerator. **(8)**

SECTION - B

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

Symbols indicate their usual meaning. Necessary steam property table is provided.

5. (a) What are the functions of economizer and superheater in a boiler? Write down the advantages of using superheated steam. **(8)**

(b) Explain the working of safety valve, fusible plug, and feed check valve in a boiler. **(10)**

(c) With the help of a suitable diagram, describe the construction and working principle of a Lancashire boiler. **(17)**

6. (a) Why is Rankine cycle preferred over Carnot cycle as the ideal vapor power cycle? **(8)**

(b) What do you understand by a binary vapor power cycle? Show the schematic diagram and T-s diagram of a binary vapor power cycle. **(9)**

(c) Steam is the working fluid in an ideal Rankine cycle. Saturated vapor enters the turbine at 18 MPa and saturated liquid exits the condenser at a pressure of 10 kPa. The turbine and the pump each have an isentropic efficiency of 85%. Considering the unit mass flow rate of the steam, determine for the cycle: **(18)**

(i) the net power output of the cycle

(ii) the thermal efficiency

(iii) back work ratio

Contd P/3

7. (a) Write down the assumptions that are made for the analysis of air standard gas turbine cycle. **(5)**

(b) What are the advantages of a combined cycle power plant? **(5)**

(c) What are the sources of irreversibility in gas turbine operation? How does the irreversibility affect the performance of gas turbine? **(8)**

(d) Air enters the compressor of a gas turbine at 0.15 MPa and 15°C and leaves the compressor at a pressure of 1.5 MPa. Maximum temperature in the cycle is 1200°C. Assume a compressor efficiency of 85%, turbine efficiency of 90%, and pressure drop of 20 kPa between the compressor and the turbine. Determine the compressor work, turbine work and thermal efficiency of the cycle. **(17)**

8. (a) What do you understand by knocking in an IC engine? Write down its cause, effects, and prevention methods. **(8)**

(b) Derive the expression for thermal efficiency of an air standard diesel cycle. **(10)**

(c) An air standard diesel cycle has a compression ratio of 16 and the heat transferred to the working fluid per cycle is 1500 kJ/kg. At the beginning of the compression process, the pressure is 0.05 MPa and the temperature is 27°C. Determine **(17)**

(i) the thermal efficiency

(ii) back work ratio

TABLE B.1.2
Saturated Water Pressure Entry

		Specific Volume, m³/kg			Internal Energy, kJ/kg		
Press. (kPa)	Temp. (°C)	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

		Enthalpy, kJ/kg			Entropy, kJ/kg-K		
Press. (kPa)	Temp. (°C)	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

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

		Specific Volume, m^3/kg			Internal Energy, kJ/kg		
Press. (kPa)	Temp. (°C)	Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Sat. Liquid u_f	Evap. u_{fg}	Sat. Vapor u_g
850	172.96	0.001118	0.22586	0.22698	731.25	1847.45	2578.69
900	175.38	0.001121	0.21385	0.21497	741.81	1838.65	2580.46
950	177.69	0.001124	0.20306	0.20419	751.94	1830.17	2582.11
1000	179.91	0.001127	0.19332	0.19444	761.67	1821.97	2583.64
1100	184.09	0.001133	0.17639	0.17753	780.08	1806.32	2586.40
1200	187.99	0.001139	0.16220	0.16333	797.27	1791.55	2588.82
1300	191.64	0.001144	0.15011	0.15125	813.42	1777.53	2590.95
1400	195.07	0.001149	0.13969	0.14084	828.68	1764.15	2592.83
1500	198.32	0.001154	0.13062	0.13177	843.14	1751.3	2594.5
1750	205.76	0.001166	0.11232	0.11349	876.44	1721.39	2597.83
2000	212.42	0.001177	0.09845	0.09963	906.42	1693.84	2600.26
2250	218.45	0.001187	0.08756	0.08875	933.81	1668.18	2601.98
2500	223.99	0.001197	0.07878	0.07998	959.09	1644.04	2603.13
2750	229.12	0.001207	0.07154	0.07275	982.65	1621.16	2603.81
3000	233.90	0.001216	0.06546	0.06668	1004.76	1599.34	2604.10
3250	238.38	0.001226	0.06029	0.06152	1025.62	1578.43	2604.04
3500	242.60	0.001235	0.05583	0.05707	1045.41	1558.29	2603.70
4000	250.40	0.001252	0.04853	0.04978	1082.28	1519.99	2602.27
5000	263.99	0.001286	0.03815	0.03944	1147.78	1449.34	2597.12
6000	275.64	0.001319	0.03112	0.03244	1205.41	1384.27	2589.69
7000	285.88	0.001351	0.02602	0.02737	1257.51	1322.97	2580.48
8000	295.06	0.001384	0.02213	0.02352	1305.54	1264.25	2569.79
9000	303.40	0.001418	0.01907	0.02048	1350.47	1207.28	2557.75
10000	311.06	0.001452	0.01657	0.01803	1393.00	1151.40	2544.41
11000	318.15	0.001489	0.01450	0.01599	1433.68	1096.06	2529.74
12000	324.75	0.001527	0.01274	0.01426	1472.92	1040.76	2513.67
13000	330.93	0.001567	0.01121	0.01278	1511.09	984.99	2496.08
14000	336.75	0.001611	0.00987	0.01149	1548.53	928.23	2476.76
15000	342.24	0.001658	0.00868	0.01034	1585.58	869.85	2455.43
16000	347.43	0.001711	0.00760	0.00931	1622.63	809.07	2431.70
17000	352.37	0.001770	0.00659	0.00836	1660.16	744.80	2404.96
18000	357.06	0.001840	0.00565	0.00749	1698.86	675.42	2374.28
19000	361.54	0.001924	0.00473	0.00666	1739.87	598.18	2338.05
20000	365.81	0.002035	0.00380	0.00583	1785.47	507.58	2293.05
21000	369.89	0.002206	0.00275	0.00495	1841.97	388.74	2230.71
22000	373.80	0.002808	0.00072	0.00353	1973.16	108.24	2081.39
22089	374.14	0.003155	0	0.00315	2029.58	0	2029.58

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

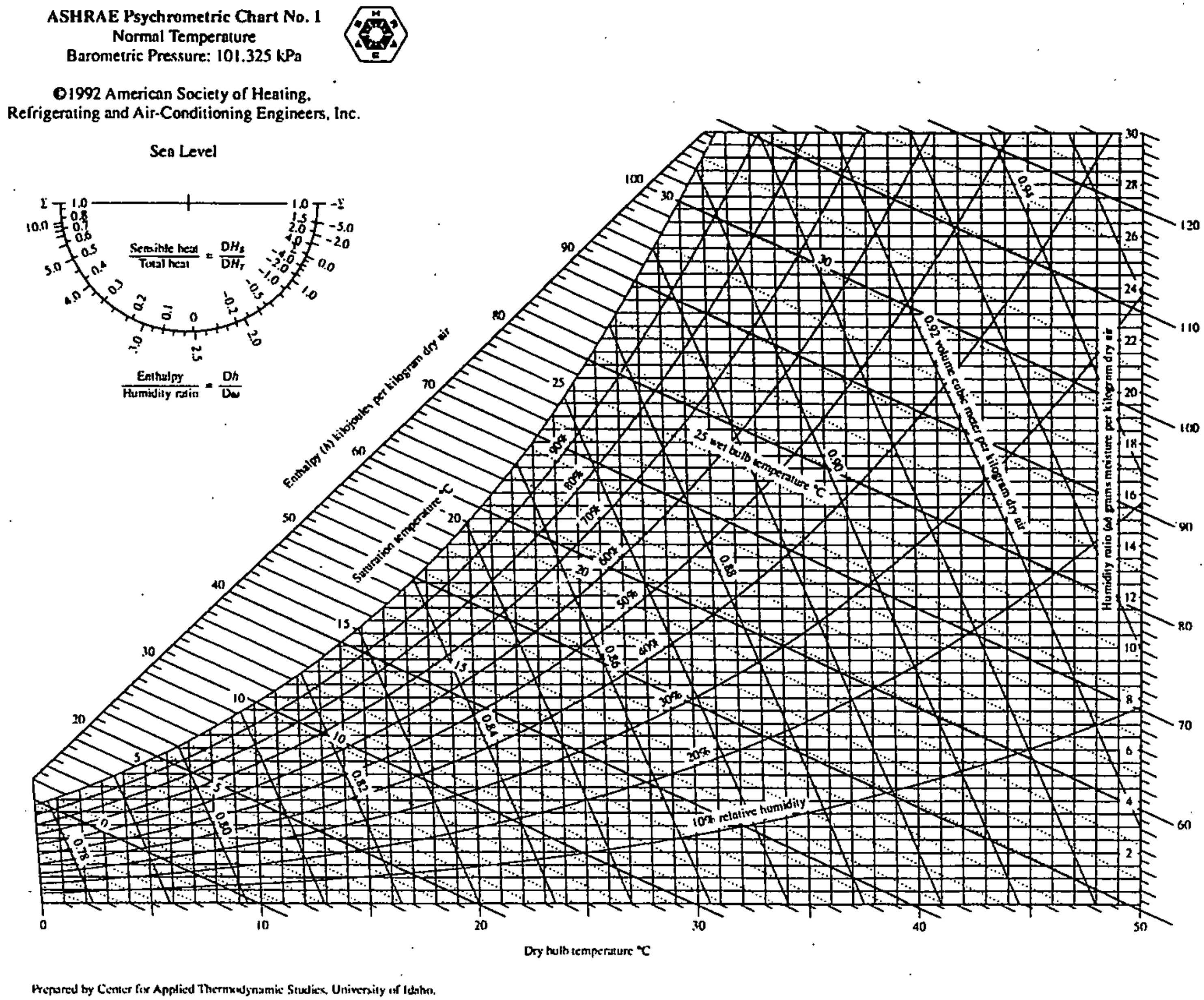

FIGURE A–31

Psychrometric chart at 1 atm total pressure.

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2017-2018

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

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) Transform the equation $17x^2+18xy-7y^2-16x-32y-18=0$ to one in which there is no term involving x, y and xy. **(18)**

(b) Find the equation of the pair of straight lines which make angles $\pi/6$ with lines represented by $ax^2+2hxy+by^2=0$. **(17)**

2. (a) Find the limiting points of the system of circles co-axial with the circles **(17)**

$$x^2+y^2-6x-6y+4=0 \text{ and } x^2+y^2-2x-4y+3=0.$$

(b) A normal at P on the parabola $y^2=16x$ meets the axis of the parabola at G and K is a point on PG such that $PK : KG = 2:1$. Find the locus of K for different positions of P. **(18)**

3. (a) Find the area of the triangle formed by the lines

$$ax^2+2hxy+by^2=0 \text{ and } lx+my+n=0\ . \qquad \textbf{(18)}$$

(b) In a rectangular hyperbola $x^2-y^2=a^2$. Show that $SP.\,S'P = OP^2$ where P is a point on the hyperbola, S and S′ are the foci and O is the centre of the hyperbola. **(17)**

4. (a) Find the locus of the point of intersection of the normals drawn at the extremities of the conjugate diameters of the ellipse $\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}=1$. **(16)**

(b) Show that the parabolas $y^2=4ax$ *and* $x^2=4by$ cut one another at an angle

$$tan^{-1}\frac{3a^{1/3}b^{1/3}}{2\left(a^{2/3}+b^{2/3}\right)}. \qquad \textbf{(19)}$$

Contd P/2

MATH 183(NAME)

SECTION – B

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

Symbols used to have their usual meaning.

5. (a) Find the differential equation of the family of curves, $y = Ae^{2x} + Be^{-2x}$, where A and B are arbitrary constants. **(7)**

   (b) Solve the initial value problem: $(x+1)\dfrac{dy}{dx} + y = \ln x,\ y(1) = 10.$ **(14)**

   (c) Solve: $\left(y^2 + xy^3\right)dx + \left(5y^2 - xy + y^3 \sin y\right)dy = 0.$ **(14)**

6. (a) Solve: $\dfrac{dy}{dx} - 2 = \sqrt{y - 2x + 3}.$ **(11)**

   (b) Solve: $3\left(1+t^2\right)\dfrac{dy}{dt} = 2yt\left(y^3 - 1\right).$ **(12)**

   (c) A small metal bar, whose initial temperature was 20°C, is dropped into a large container of boiling water. How long will it take the bar to reach 90°C if it is known that its temperature increases 2° in 1 second? How long will it take the bar to reach 98°C? **(12)**

7. Solve the following differential equations:

   (a) $2\dfrac{d^5y}{dx^5} - 7\dfrac{d^4y}{dx^4} + 12\dfrac{d^3y}{dx^3} + 8\dfrac{d^2y}{dx^2} = 0.$ **(11)**

   (b) $\dfrac{d^2y}{dx^2} - \dfrac{dy}{dx} = 8e^{3x} + 4\sin x.$ **(12)**

   (c) $4\dfrac{d^2y}{dx^2} + 36y = \operatorname{cosec} 3x.$ **(12)**

8. Solve the following:

   (a) $x\dfrac{d^2y}{dx^2} + \dfrac{dy}{dx} - \dfrac{1}{x}y = \ln x.$ **(11)**

   (b) $y(1 - \ln y)\dfrac{d^2y}{dx^2} + (1 + \ln y)\left(\dfrac{dy}{dx}\right)^2 = 0.$ **(12)**

   (c) $\dfrac{d^2y}{dx^2} + \dfrac{dy}{dx} + \left(\dfrac{dy}{dx}\right)^3 = 0.$ **(12)**

L-1/T-2/NAME **Date : 25/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2017-2018

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

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) **(10)**

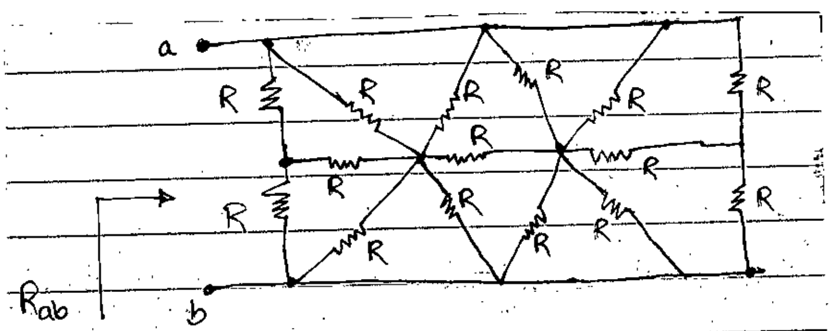


fig. for Q. 1(a)

Find the equivalent resistance R_{ab} in fig. for Q. 1(a).

(b) **(7)**

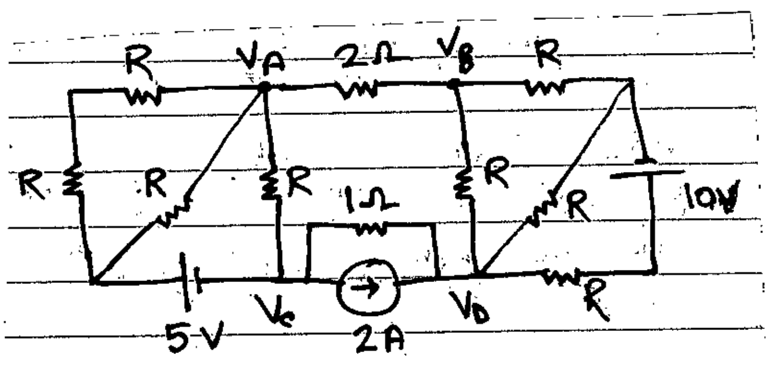


fig for Q. 1(b)

In fig. for Q.1(b), if $V_A - V_B = 6V$, find $V_C - V_D$.

(c) **(18)**

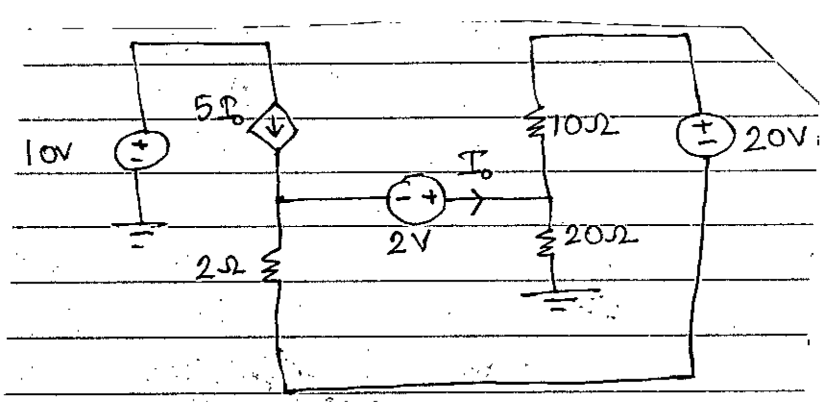


fig. for Q. 1(c)

Using nodal analysis, find the node voltages for the circuit in fig for Q. 1(c).

Contd P/2

2. (a) **(15)**

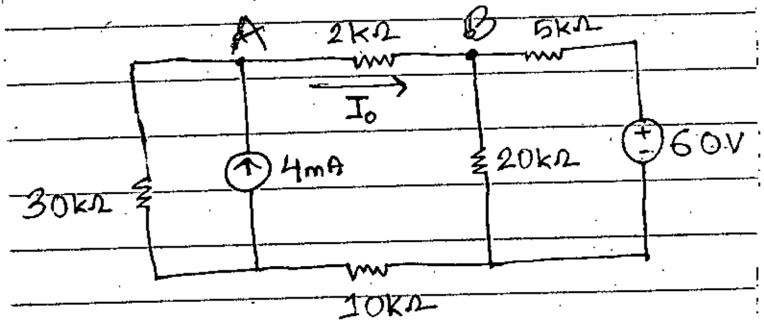


fig. for Q. 2(a)

Consider the circuit in fig. for Q.2(a). An ammeter with internal resistance R_i is inserted between A and B to measure I_0. Determine the reading of the ammeter if:

(i) $R_i = 0\Omega$

(ii) $R_i = 500\Omega$

(b) Find the current in the 10kΩ resistor (i_0) making successive appropriate source transformations in Fig. for Q. 2(b). **(12)**

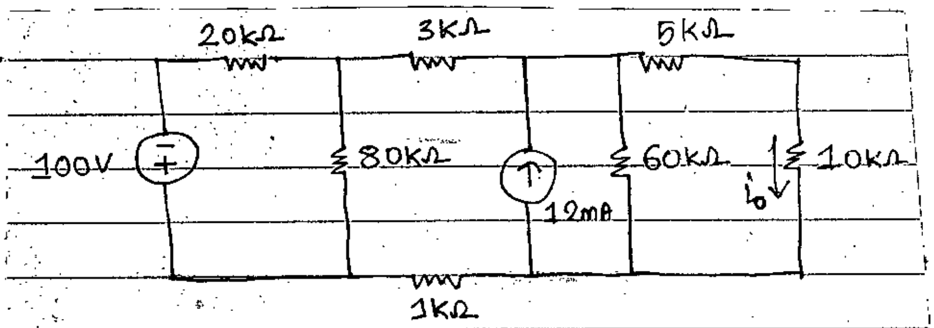


fig. for Q. 2(b)

(c) **(8)**

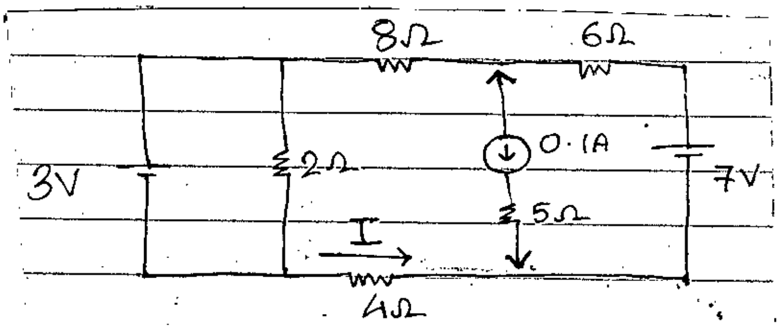


fig. for Q. 2(c)

The current 'I' in the circuit for fig. for Q.2(c) before connecting the current source is 0.222A. What is the change in the current after connecting the branch with the current source?

EEE 161

3. (a) **(17)**

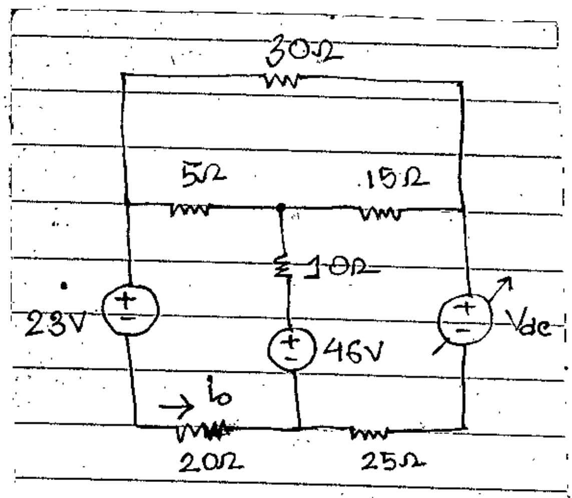


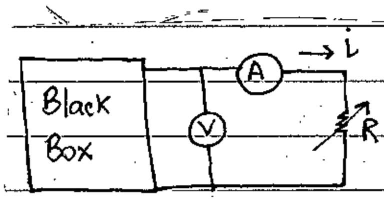
fig. for Q3(a)

The variable dc voltage source in the circuit in Fig. for Q. 3(a) is adjusted so that i_o is zero.

(i) Find the value of V_{dc}.

(ii) Show that the power developed equals the power dissipated for the circuit.

(b) **(10)**



R(Ω)	V(V)	i(A)
2	3	1.5
8	8	1.0
14	10.5	0.75

fig. for Q. 3(b)

A black box with a circuit is connected to a variable resistor. An ideal ammeter (with zero resistance) and an ideal voltmeter (with infinite resistance) are used to measure current and voltage as shown in Fig. for Q. 3(b). The results are shown in the table corresponding to it.

Determine the maximum power available from the back box.

(c) You are given a black box with three terminals as shown in Fig. for Q. 3(c). The box is known to contain five 1Ω resistors. Using an ohm-meter, you measure the resistance between the terminals as: **(8)**

$$A - B = 1.5\Omega, \quad B - C = 3\Omega, \quad A - C = 2.5\Omega$$

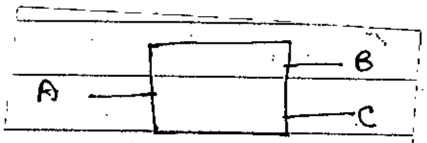


Fig. for Q. 3(c)

Determine the configuration of the five resistors inside the box.

EEE 161

4. (a) A 50hp, 250V, 1200 r/min dc shunt motor with compensating windings has an armature resistance of 0.06Ω. Its field circuit has a total resistance $R_{adj} + R_F$ of 50Ω, which produces a no-load speed of 1200 r/min. There are 1200 turns per pole on the shunt field winding. **(12)**

   (i) Find the speed of this motor when its input current is 200A.

   (ii) Find the induced torque under this condition.

   Consider the same motor without compensating windings.

   The armature reaction produces a demagnetizing magnetomotive force of 840A-turns at a load current of 200A. The open circuit terminal voltage at the effective field current (corresponding to load current of 200A) is 233V.

   (i) Find the speed and induced torque of the motor without compensating windings.

   (ii) Compare between the speed and induced torque of the motor with and without compensating windings explaining its effect.

   (b) Describe, with the help of graphs, the speed control methods of shunt DC motors. **(12)**

   (c) Explain the problem related to starting a DC motor. Draw a DC motor starting circuit using courter voltage-sensing relays and explain how it provides necessary control and protection to a DC motor. **(11)**

SECTION - B

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

5. (a) Find I_b and Z in the circuit shown in Fig. for Q. 5(a) if $V_g = 25\angle 0°\ V$ and $I_a = 5\angle 90°\ A$. **(18)**

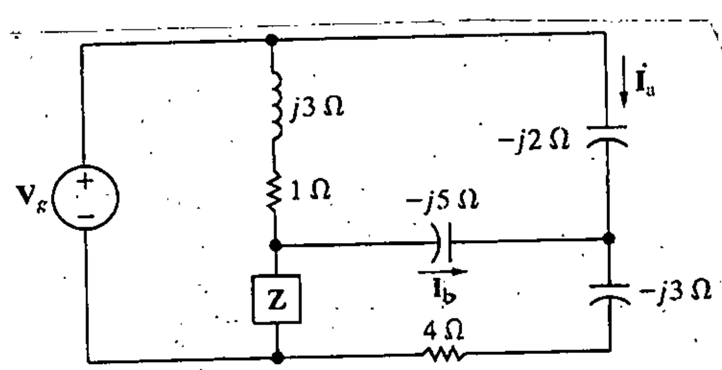


Fig. for Q. 5(a)

   (b) The source voltage in the circuit in Fig. for Q. 5(b) is $V_g = 50\cos(50{,}000t)\ V$. **(17)**

   (i) Find the values of L such that i_g is in phase with v_g when the circuit is operating in the steady state.

   (ii) For the values of L found in (i), find the steady state expressions for i_g.

Contd P/5

Contd... Q. No. 5(b)

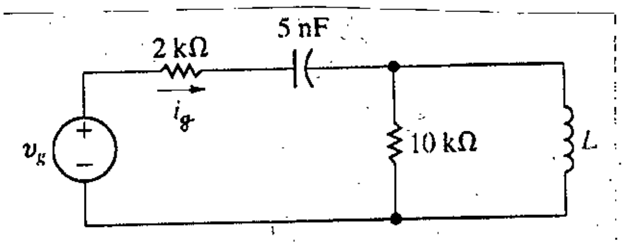


Fig. for Q. 5(b)

6. (a) Find i_o in the circuit of Fig. for Q. 6(a). **(20)**

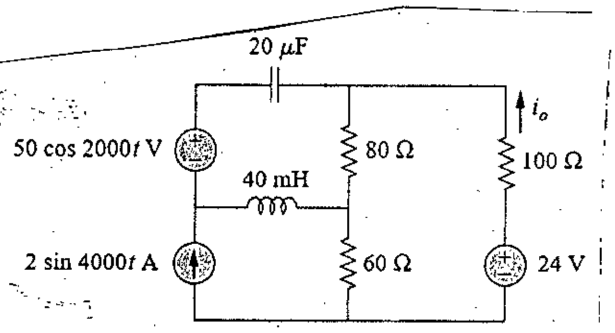


Fig. for Q. 6(a)

(b) The device in Fig for Q. 6(b) is represented in the frequency domain by a Norton equivalent. When a resistor having an impedance of 5 $k\Omega$ is connected across the device, the value of V_0 is $5 - j15$ V. When a capacitor having an impedance of $-j3k\Omega$ is connected across the device, the value of I_0 is $4.5 - j6$ mA. Find the Norton current I_N and the Norton impedance Z_N. **(15)**

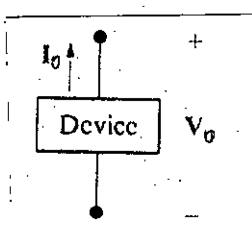


Fig. for Q. 6(b)

7. (a) The variable resistor R_0 in the circuit shown in Fig. for Q. 7(a) is adjusted until maximum average power is delivered to R_0. **(20)**

(i) What is the value of R_0 in ohms?

(ii) If R_0 is replaced by a variable impedance Z_0, what is the maximum average power delivered to Z_0?

Contd P/6

EEE 161

Contd... Q. No. 7(a)

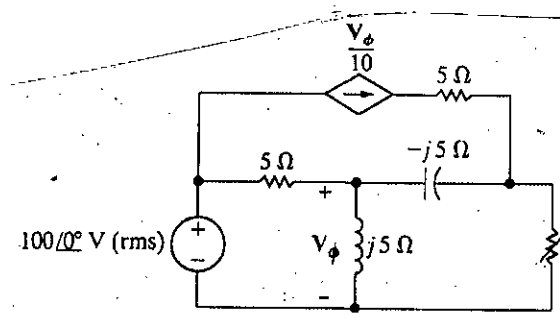


Fig. for Q. 7(a)

(b) Determine the line currents for the three-phase circuit of Fig. for Q. 7(b). Assume $V_a = 110\angle 0°$, $V_b = 110\angle -120°$ and $V_c = 110\angle 120°$. **(15)**

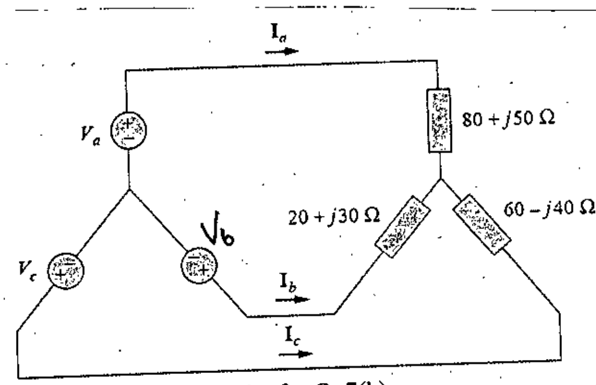


Fig. for Q. 7(b)

8. (a) Draw the connections for transformer open-circuit and short-circuit tests. **(5)**

(b) For a 20 kVA, 8000/240 V, 60 Hz transformer, the open-circuit test data and the short-circuit test data are given as follows, **(20)**

Open Circuit Test	Short Circuit Test
$V_{OC} = 8000\ V$	$V_{SC} = 500\ V$
$I_{OC} = 0.3\ A$	$I_{SC} = 2.5\ A$
$P_{OC} = 500\ W$	$P_{SC} = 200\ W$

Draw the approximate equivalent circuit for this transformer.

(c) Derive the voltage and current relationship of an auto- transformer. **(10)**

L-1/T-2/NAME **Date : 14/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2017-2018

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

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**.

Assume reasonable value for missing data (if any).

1. (a) What are the different types of similarities which may exist between a model and its prototype? Explain the different similarities. **(20)**

(b) The kinematic viscosity of a fluid used for model is one third of the kinematic viscosity of the fluid used for prototype. During testing of the model, if viscosity and gravity forces are predominant, find the scale ratio, velocity ratio and discharge ratio. **(15)**

2. (a) For jet propulsion of a ship, when inlet orifice facing the direction of motion of the ship, show that the propulsion efficiency is given by: **(15)**

$$\eta = \frac{2u}{v + 2u}$$

Where, V = Velocity of jet coming out at the back of ship

u = Relative velocity of jet with respect to ship.

(b) In a jet propelled ship water enters through inlet orifices faces in the direction of motion and discharging at the rate of 17 m/s relative to ship. The speed of the ship is 5.5 m/s and the cross-sectional area of jet is 0.25 m^2. Find the propelling force, power exerted by jet and efficiency of propulsion. **(20)**

3. (a) Describe the effect of pressure gradient on the boundary layer development when a fluid is flowing over a curved surface. **(10)**

(b) What do you mean by boundary layer displacement thickness and momentum thickness? **(10)**

(c) Are low-speed, small-scale air and water boundary layers really thin? Consider flow at u = 1ft/s past a flat plate 1 ft long. Compute the boundary layer thickness at the trailing edge for air and water at 68°F. Given, **(15)**

γ air = 1.61×10^{-4} ft^2/s

γ water = 1.08×10^{-5} ft^2/s

4. (a) What do you mean by cavitation? Describe the effects of cavitation on ship's propeller. **(20)**

Contd P/2

NAME 123

Contd... Q. No. 4

(b) How can you reduce the occurrence of cavitation on ship's propeller? **(5)**

(c) A cylinder 80 mm diameter and 200 mm long is placed in a stream of fluid flowing at 0.5 m/s. The axis of the cylinder is normal to the direction of flow. The density of the fluid is 800 kg/m^3. The drag force is measured and found to be 30N. At a point on the surface, the pressure is measured as 96 Pa above the ambient level. Calculate **(10)**

(i) the drag coefficient

(ii) the velocity at the point on the surface where pressure is measured.

SECTION - B

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

Symbols have their usual meaning. Assume reasonable value in case of any missing value.

5. (a) Describe the physical significance of Reynold's number in fluid flow. In a tabular form, mention the differences between Laminar and Turbulent flow. **(15)**

   (b) A rectangular plate of 3.5 m long and 2.5 m wide is immersed in water in such a way that its plane makes an angle of 45° with the free surface of water. If the upper edge of the plate is 1.5 m vertically below the free water surface, find the magnitude and the location of resultant force acting on the plate. **(20)**

6. (a) With the help of schematic diagram define hydrodynamic entry length. Describe the regions where the major and minor losses occur when a fluid flows in a pipe. **(18)**

   (b) Water is flowing through a 1 m diameter and 1000 m long pipe at the rate of 3 m^3/s from on reservoir to another. The wall roughness for the pipe is equal to 0.5 mm. The loss coefficient (k) at the entrance and exit of the pipe are 0.5 and 1.0 respectively. Find the difference in water surface elevation between the two reservoirs. Kinematic viscosity of water is 1.02×10^{-6} m^2/s. **(17)**

7. (a) Write short notes on: **(18)**

   (i) Selection criteria of pump

   (ii) Pump in series and parallel

   (iii) Pump system curve

   (b) Mention the differences between reciprocating and centrifugal pump. **(10)**

   (c) How do you find the operating point of a pump? Describe with the help of curves. **(7)**

8. (a) Show that the head loss due to sudden expansion in pipeline is a function of velocity head. **(18)**

   (b) The air is flowing through a nozzle. The inlet pressure is p_1 = 105 kPa abs, and the air exhausts into the atmosphere, where the pressure is 101.3 kPa abs. The nozzle has an inlet diameter of 60 mm and an exit diameter of 10 mm and the nozzle is connected to the supply pipe by flanges. Find the air speed at the exit of the nozzle and the force required to hold the nozzle stationary. Assume the air has a constant density of 1.22 kg/m^3. Neglect the weight of the nozzle. **(17)**

NAME 123

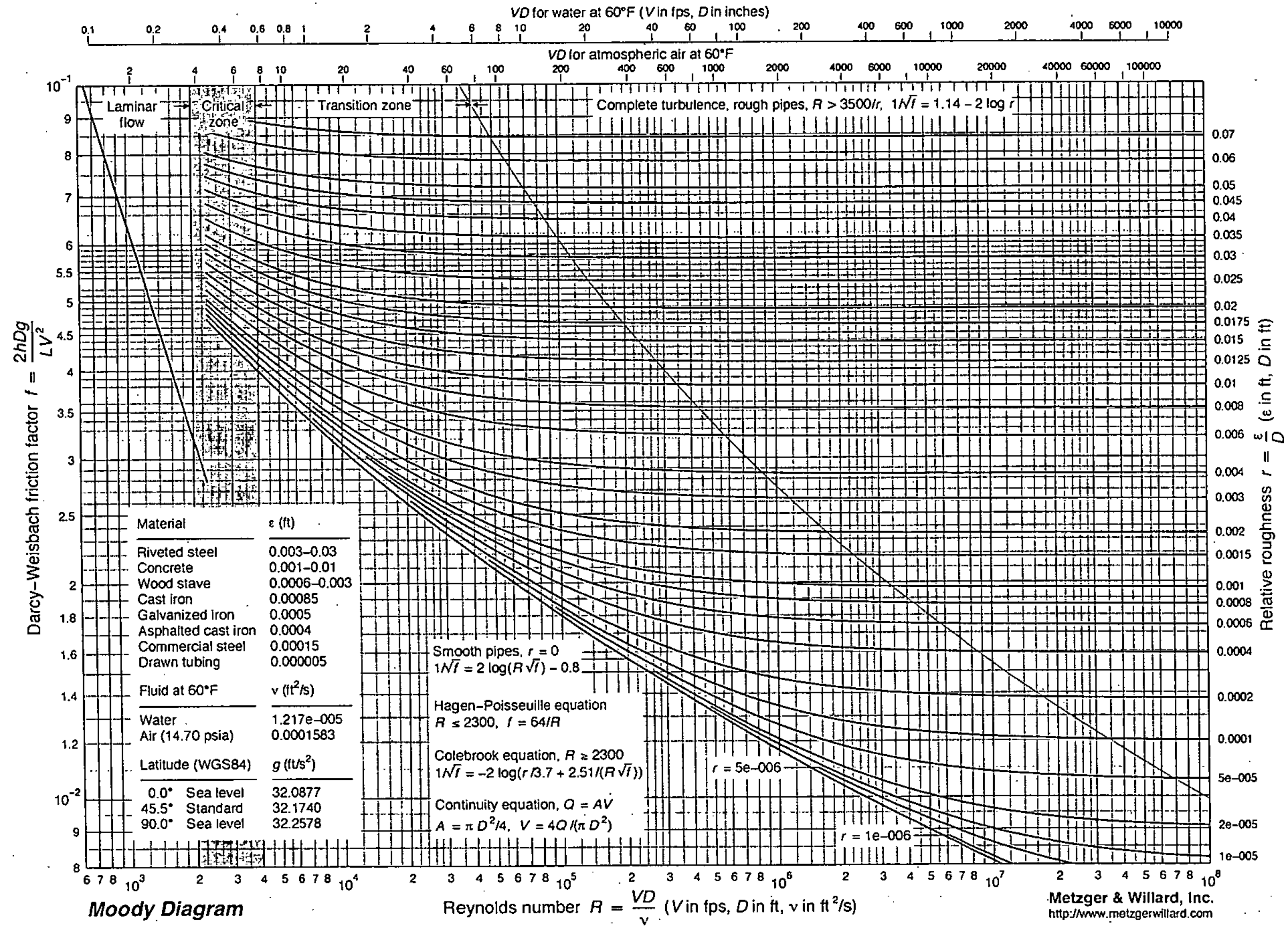


Fig. for Q. No. 6(b)

— X —

L-1/T-1/NAME **Date : 01/10/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B.Sc. Engineering Examinations 2017-2018

Sub : **PHY 113** (Structure of Matter, Electricity, Magnetism and Modern Physics)

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) Write down Lorentz transformation equations and using these equations explain relativity of time and length. **(14)**

   (b) Moving body has larger mass than a stationary body. Find an expression for relative mass to prove this statement. **(15)**

   (c) What is the percentage increase in the mass of an electron accelerated at a kinetic energy of 500 MeV? Rest mass of an electron is 9.1×10^{-31}kg. **(6)**

2. (a) Explain uncertainty principle and wave-particle duality. Why electron cannot stay inside a nucleus? **(12)**

   (b) Define photoelectric effect and graphically represent the results of photoelectric effect. Why quantum theory is required to explain the results of photoelectric effect? **(15)**

   (c) The maximum wavelength for photoelectric emission in tugsten is 230 nm. What wavelength of light must be used in order for electrons with a maximum energy of 1.5 eV to be ejected? **(8)**

3. (a) Define average binding energy for a nucleus and describe the binding energy curve. **(10)**

   (b) Briefly explain different types of nuclear reactions and the three situations of nuclear fission reaction. **(13)**

   (c) Discuss the advantages and limitations of nuclear fission reactor and fusion reactor as sources of renewable energy. The isotope Iodine-129 has a half-life of 15.7 years. In a nuclear power plant accident 1 kg of the isotope is dispersed into the surroundings of the plant. How much of the iodine isotope will remain in the surroundings after 1, 10, and 100 years? **(12)**

4. (a) What is Crystallography? Briefly explain the classification of solids with examples from the crystallographic point of view. **(10)**

   (b) What are seven crystal systems of Bravias lattice? Draw various unit cells orthorhombic and cubic crystal systems mentioning their lattice point per unit cell. **(12)**

   (c) Explain how to draw a Wigner-Seitz cell. **(7)**

   (d) Briefly explain why 5, 7 or 8 fold does not exist in crystallographic symmetry. **(6)**

Contd P/2

PHY 113/NAME

SECTION - B

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

5. (a) Define packing factor for a crystal structure. Find the packing factor of a body centered cubic and face centered cubic crystal considering atoms as sphere. **(12)**

   (b) Draw the crystal planes having Miller indices (101), (111) and (231) in a cubic unit cell. **(6)**

   (c) Find the general expression for interplanar spacing in terms of lattice parameters and Miller indices (*hkl*) for crystal structure. How this general expression is applicable to the primitive lattice of orthorhombic, tetragonal and cubic system? **(12)**

   (d) The lattice parameters of a tetragonal system are given by $a = b = 2.42$Å and c = 1.74Å. Find the interplanar spacing for (101) plane. **(5)**

6. (a) Write down some importance of imperfections in solid materials. Draw a figure showing various types crystal imperfections together. **(8)**

   (b) What is cohesive energy? Derive an expression for cohesive energy of a NaCl ionic crystal. **(18)**

   (c) In a NaCl crystal, the equilibrium distance r_0 between ions is 0.285 nm. Find the cohesive energy in NaCl. Provided that ionization energy for Na is +5.15 eV and electron affinity of Cl is -3.62 eV. **(9)**

7. (a) What are polar and non-polar dielectrics? **(6)**

   (b) Show that the capacitance of a parallel plate capacitor with a compound dielectrics is **(20)**

$$C = \frac{K\varepsilon_0 A}{t + K(d - t)}$$

   where K is the dielectric constant of the slab, ε_0 is the permittivity of air, t is the thickness of the slab and d is the separation between the plates.

   (c) A parallel plate capacitor has a capacitance of 100μF, a plate area of 100 cm^2 and a mica sheet of dielectric constant, K = 5.4. If the potential difference in between the parallel plates is 50 V, calculate (i) electric field in mica sheet, (ii) the free charge on the plates, and (iii) the induced charge. **(9)**

8. (a) State and explain Curie's law in magnetism. **(5)**

   (b) Define the following terms: (i) Diamagnetic materials, (ii) paramagnetic materials, (iii) Ferromagnetic materials, and (iv) Antiferromagnetic materials. **(10)**

   (c) What is magnetic hysteresis loop? Describe a method for obtaining hysteresis loop. **(12)**

   (d) Explain the terms (i) Remanence and (ii) Coercivity. How will you characterize the soft and hard magnetic materials? **(8)**
