L-4/T-2/ME **Date : 16/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 403** (Power Plant 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**.

Steam Tables are supplied. Assume reasonable values fro missing data, if any.

1. (a) Discuss the current status and future of coal, oil, gas, and nuclear as energy sources in the world. Your answer should also highlight the energy scenario in Bangladesh. **(20)**

   (b) What are the parameters to be considered in choosing a site for a hydro-electric power plant? Discuss and compare a hydro-electric plant with other renewable energy sources. **(15)**

2. (a) Explain the load curve and the load duration curve in a power system. What are their usages? **(10)**

   (b) Explain different types of electrical tariff methods. **(10)**

   (c) The maximum load on a thermal power plant of 60 MW capacity is 50 MW at an annual load factor of 0.50. The loads having maximum demands of 25 MW, 20 MW, 8 MW, and 5 MW are connected to the power station. Determine : (i) average load on power station, (ii) energy generated per year, (iii) demand factor, and (iv) diversity factor. **(10)**

   (d) What is diversity factor? What happens to the load factor of a power system if the diversity factor changes? **(5)**

3. (a) What are the advantages of fluidised bed combustion (FBC)? Explain with a neat sketch the operation of a circulating fluidised bed boiler. **(15)**

   (b) Discuss in detail, with a block diagram, the layout of an IGCC power plant. **(15)**

   (c) Write short notes on staging of steam turbines. **(5)**

4. (a) Why are condensers used in a steam power plant? Briefly describe the operation of a surface condenser with a neat sketch. **(10)**

   (b) A condenser for a steam power plant receives 185 tons per hour of steam at 40°C, 92% quality. Cooling water enters at 33°C and leaves at 37°C. The condensate leaves at 39°C. The pressure in the condenses is 0.077 bar. **(20)**

   Find, (i) the cooling water flow required in m^3/s, and (ii) the condenser efficiency.

   (c) What is a deaerator heater? Why is it located at a sufficient height above the boiler feed pump? **(5)**

Contd P/2

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SECTION – B

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

5. (a) Make brief comparisons between: **(10)**

   (i) gas turbine and steam turbine

   (ii) gas turbine and piston engines.

   (b) Explain the working principle and the effects of regeneration on gas turbines. **(10)**

   (c) Draw a schematic diagram of a practical ICRHR cycle and present a typical performance map (η vs specific work). **(15)**

6. (a) Make brief comparisons between: **(10)**

   (i) S1 engines and CI engines for power generation applications

   (ii) turbo-charging and supercharging of CI engines.

   (b) With schematic diagrams, explain the working principle of a CI engine turbocharger with intercooler, and waste-gate. **(10)**

   (c) Make brief comparisons between 3 types of gas engines used in power generation. **(15)**

7. (a) Make brief comparison between: **(10)**

   (i) U-235 and U-238

   (ii) Nuclear fission and fusion

   (b) With schematic diagrams, explain the essential features of thermal fission reactors. **(10)**

   (c) Write short notes on **(15)**

   (i) PWR reactor

   (ii) BWR reactor

   (iii) CANDU reactor

8. (a) Make brief comparisons between: **(10)**

   (i) Co-generation and regeneration

   (ii) Brayton cycle and combined cycle.

   (b) Write a short note on nuclear power by mentioning favourable and unfabourable drives for it. **(10)**

   (c) Make a thermodynamic analysis of a gas turbine combined cycle, Briefly present energy flow diagram and performance parameters of such system. **(15)**

Table A-2 Properties of Saturated Water (Liquid–Vapor): Temperature Table

Pressure Conversions: 1 bar = 0.1 MPa = 10^2 kPa

Temp. °C	Press. bar	Specific Volume m^3/kg		Internal Energy kJ/kg		Enthalpy kJ/kg			Entropy kJ/kg · K		Temp. °C
		Sat. Liquid $v_f \times 10^3$	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g	
01	0.00611	1.0002	206.136	0.00	2375.3	0.01	2501.3	2501.4	0.0000	9.1562	01
4	0.00813	1.0001	157.232	16.77	2380.9	16.78	2491.9	2508.7	0.0610	9.0514	4
5	0.00872	1.0001	147.120	20.97	2382.3	20.98	2489.6	2510.6	0.0761	9.0257	5
6	0.00935	1.0001	137.734	25.19	2383.6	25.20	2487.2	2512.4	0.0912	9.0003	6
8	0.01072	1.0002	120.917	33.59	2386.4	33.60	2482.5	2516.1	0.1212	8.9501	8
10	0.01228	1.0004	106.379	42.00	2389.2	42.01	2477.7	2519.8	0.1510	8.9008	10
11	0.01312	1.0004	99.857	46.20	2390.5	46.20	2475.4	2521.6	0.1658	8.8765	11
12	0.01402	1.0005	93.784	50.41	2391.9	50.41	2473.0	2523.4	0.1806	8.8524	12
13	0.01497	1.0007	88.124	54.60	2393.3	54.60	2470.7	2525.3	0.1953	8.8285	13
14	0.01598	1.0008	82.848	58.79	2394.7	58.80	2468.3	2527.1	0.2099	8.8048	14
15	0.01705	1.0009	77.926	62.99	2396.1	62.99	2465.9	2528.9	0.2245	8.7814	15
16	0.01818	1.0011	73.333	67.18	2397.4	67.19	2463.6	2530.8	0.2390	8.7582	16
17	0.01938	1.0012	69.044	71.38	2398.8	71.38	2461.2	2532.6	0.2535	8.7351	17
18	0.02064	1.0014	65.038	75.57	2400.2	75.58	2458.8	2534.4	0.2679	8.7123	18
19	0.02198	1.0016	61.293	79.76	2401.6	79.77	2456.5	2536.2	0.2823	8.6897	19
20	0.02339	1.0018	57.791	83.95	2402.9	83.96	2454.1	2538.1	0.2966	8.6672	20
21	0.02487	1.0020	54.514	88.14	2404.3	88.14	2451.8	2539.9	0.3109	8.6450	21
22	0.02645	1.0022	51.447	92.32	2405.7	92.33	2449.4	2541.7	0.3251	8.6229	22
23	0.02810	1.0024	48.574	96.51	2407.0	96.52	2447.0	2543.5	0.3393	8.6011	23
24	0.02985	1.0027	45.883	100.70	2408.4	100.70	2444.7	2545.4	0.3534	8.5794	24
25	0.03169	1.0029	43.360	104.88	2409.8	104.89	2442.3	2547.2	0.3674	8.5580	25
26	0.03363	1.0032	40.994	109.06	2411.1	109.07	2439.9	2549.0	0.3814	8.5367	26
27	0.03567	1.0035	38.774	113.25	2412.5	113.25	2437.6	2550.8	0.3954	8.5156	27
28	0.03782	1.0037	36.690	117.42	2413.9	117.43	2435.2	2552.6	0.4093	8.4946	28
29	0.04008	1.0040	34.733	121.60	2415.2	121.61	2432.8	2554.5	0.4231	8.4739	29
30	0.04246	1.0043	32.894	125.78	2416.6	125.79	2430.5	2556.3	0.4369	8.4533	30
31	0.04496	1.0046	31.165	129.96	2418.0	129.97	2428.1	2558.1	0.4507	8.4329	31
32	0.04759	1.0050	29.540	134.14	2419.3	134.15	2425.7	2559.9	0.4644	8.4127	32
33	0.05034	1.0053	28.011	138.32	2420.7	138.33	2423.4	2561.7	0.4781	8.3927	33
34	0.05324	1.0056	26.571	142.50	2422.0	142.50	2421.0	2563.5	0.4917	8.3728	34
35	0.05628	1.0060	25.216	146.67	2423.4	146.68	2418.6	2565.3	0.5053	8.3531	35
36	0.05947	1.0063	23.940	150.85	2424.7	150.86	2416.2	2567.1	0.5188	8.3336	36
38	0.06632	1.0071	21.602	159.20	2427.4	159.21	2411.5	2570.7	0.5458	8.2950	38
40	0.07384	1.0078	19.523	167.56	2430.1	167.57	2406.7	2574.3	0.5725	8.2570	40
45	0.09593	1.0099	15.258	188.44	2436.8	188.45	2394.8	2583.2	0.6387	8.1648	45
50	.1235	1.0121	12.032	209.32	2443.5	209.33	2382.7	2592.1	.7038	8.0763	50
55	.1576	1.0146	9.568	230.21	2450.1	230.23	2370.7	2600.9	.7679	7.9913	55
60	.1994	1.0172	7.671	251.11	2456.6	251.13	2358.5	2609.6	.8312	7.9096	60
65	.2503	1.0199	6.197	272.02	2463.1	272.06	2346.2	2618.3	.8935	7.8310	65
70	.3119	1.0228	5.042	292.95	2469.6	292.98	2333.8	2626.8	.9549	7.7553	70
75	.3858	1.0259	4.131	313.90	2475.9	313.93	2321.4	2635.3	1.0155	7.6824	75
80	.4739	1.0291	3.407	334.86	2482.2	334.91	2308.8	2643.7	1.0753	7.6122	80
85	.5783	1.0325	2.828	355.84	2488.4	355.90	2296.0	2651.9	1.1343	7.5445	85
90	.7014	1.0360	2.361	376.85	2494.5	376.92	2283.2	2660.1	1.1925	7.4791	90
95	.8455	1.0397	1.982	397.88	2500.6	397.96	2270.2	2668.1	1.2500	7.4159	95
100	1.014	1.0435	1.673	418.94	2506.5	419.04	2257.0	2676.1	1.3069	7.3549	100
110	1.433	1.0516	1.210	461.14	2518.1	461.30	2230.2	2691.5	1.4185	7.2387	110
120	1.985	1.0603	0.8919	503.50	2529.3	503.71	2202.6	2706.3	1.5276	7.1296	120
130	2.701	1.0697	0.6685	546.02	2539.9	546.31	2174.2	2720.5	1.6344	7.0269	130
140	3.613	1.0797	0.5089	588.74	2550.0	589.13	2144.7	2733.9	1.7391	6.9299	140
150	4.758	1.0905	0.3928	631.68	2559.5	632.20	2114.3	2746.5	1.8418	6.8379	150
160	6.178	1.1020	0.3071	674.86	2568.4	675.55	2082.6	2758.1	1.9427	6.7502	160
170	7.917	1.1143	0.2428	718.33	2576.5	719.21	2049.5	2768.7	2.0419	6.6663	170
180	10.02	1.1274	0.1941	762.09	2583.7	763.22	2015.0	2778.2	2.1396	6.5857	180
190	12.54	1.1414	0.1565	806.19	2590.0	807.62	1978.8	2786.4	2.2359	6.5079	190
200	15.54	1.1565	0.1274	850.65	2595.3	852.45	1940.7	2793.2	2.3309	6.4323	200
210	19.06	1.1726	0.1044	895.53	2599.5	897.76	1900.7	2798.5	2.4248	6.3585	210
220	23.18	1.1900	0.08619	940.87	2602.4	943.62	1858.5	2802.1	2.5178	6.2861	220
230	27.95	1.2088	0.07158	986.74	2603.9	990.12	1813.8	2804.0	2.6099	6.2146	230
240	33.44	1.2291	0.05976	1033.2	2604.0	1037.3	1766.5	2803.8	2.7015	6.1437	240
250	39.73	1.2512	0.05013	1080.4	2602.4	1085.4	1716.2	2801.5	2.7927	6.0730	250
260	46.88	1.2755	0.04221	1128.4	2599.0	1134.4	1662.5	2796.6	2.8838	6.0019	260
270	54.99	1.3023	0.03564	1177.4	2593.7	1184.5	1605.2	2789.7	2.9751	5.9301	270
280	64.12	1.3321	0.03017	1227.5	2586.1	1236.0	1543.6	2779.6	3.0668	5.8571	280
290	74.36	1.3656	0.02557	1278.9	2576.0	1289.1	1477.1	2766.2	3.1594	5.7821	290
300	85.81	1.4036	0.02167	1332.0	2563.0	1344.0	1404.9	2749.0	3.2534	5.7045	300
320	112.7	1.4988	0.01549	1444.6	2525.5	1461.5	1238.6	2700.1	3.4480	5.5362	320
340	145.9	1.6379	0.01080	1570.3	2464.6	1594.2	1027.9	2622.0	3.6594	5.3357	340
360	186.5	1.8925	0.006945	1725.2	2351.5	1760.5	720.5	2481.0	3.9147	5.0526	360
374.14	220.9	3.155	0.003155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298	374.14

Source: Tables A-2 through A-5 are extracted from J. H. Keenan, F. G. Keyes, P. G. Hill, and J. G. Moore, *Steam Tables*, Wiley, New York, 1969.

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Table A-3 Properties of Saturated Water (Liquid–Vapor): Pressure Table

Pressure Conversions: 1 bar = 0.1 MPa = 10^2 kPa

Press. bar	Temp. °C	Specific Volume m^3/kg Sat. Liquid $v_f \times 10^3$	Specific Volume m^3/kg Sat. Vapor v_g	Internal Energy kJ/kg Sat. Liquid u_f	Internal Energy kJ/kg Sat. Vapor u_g	Enthalpy kJ/kg Sat. Liquid h_f	Enthalpy kJ/kg Evap. h_{fg}	Enthalpy kJ/kg Sat. Vapor h_g	Entropy kJ/kg · K Sat. Liquid s_f	Entropy kJ/kg · K Sat. Vapor s_g	Press. bar
0.04	28.96	1.0040	34.800	121.45	2415.2	121.46	2432.9	2554.4	0.4226	8.4746	0.04
0.06	36.16	1.0064	23.739	151.53	2425.0	151.53	2415.9	2567.4	0.5210	8.3304	0.06
0.08	41.51	1.0084	18.103	173.87	2432.2	173.88	2403.1	2577.0	0.5926	8.2287	0.08
0.10	45.81	1.0102	14.674	191.82	2437.9	191.83	2392.8	2584.7	0.6493	8.1502	0.10
0.20	60.06	1.0172	7.649	251.38	2456.7	251.40	2358.3	2609.7	0.8320	7.9085	0.20
0.30	69.10	1.0223	5.229	289.20	2468.4	289.23	2336.1	2625.3	0.9439	7.7686	0.30
0.40	75.87	1.0265	3.993	317.53	2477.0	317.58	2319.2	2636.8	1.0259	7.6700	0.40
0.50	81.33	1.0300	3.240	340.44	2483.9	340.49	2305.4	2645.9	1.0910	7.5939	0.50
0.60	85.94	1.0331	2.732	359.79	2489.6	359.86	2293.6	2653.5	1.1453	7.5320	0.60
0.70	89.95	1.0360	2.365	376.63	2494.5	376.70	2283.3	2660.0	1.1919	7.4797	0.70
0.80	93.50	1.0380	2.087	391.58	2498.8	391.66	2274.1	2665.8	1.2329	7.4346	0.80
0.90	96.71	1.0410	1.869	405.06	2502.6	405.15	2265.7	2670.9	1.2695	7.3949	0.90
1.00	99.63	1.0432	1.694	417.36	2506.1	417.46	2258.0	2675.5	1.3026	7.3594	1.00
1.50	111.4	1.0528	1.159	466.94	2519.7	467.11	2226.5	2693.6	1.4336	7.2233	1.50
2.00	120.2	1.0605	0.8857	504.49	2529.5	504.70	2201.9	2706.7	1.5301	7.1271	2.00
2.50	127.4	1.0672	0.7187	535.10	2537.2	535.37	2181.5	2716.9	1.6072	7.0527	2.50
3.00	133.6	1.0732	0.6058	561.15	2543.6	561.47	2163.8	2725.3	1.6718	6.9919	3.00
3.50	138.9	1.0786	0.5243	583.95	2546.9	584.33	2148.1	2732.4	1.7275	6.9405	3.50
4.00	143.6	1.0836	0.4625	604.31	2553.6	604.74	2133.8	2738.6	1.7766	6.8959	4.00
4.50	147.9	1.0882	0.4140	622.25	2557.6	623.25	2120.7	2743.9	1.8207	6.8565	4.50
5.00	151.9	1.0926	0.3749	639.68	2561.2	640.23	2108.5	2748.7	1.8607	6.8212	5.00
6.00	158.9	1.1006	0.3157	669.90	2567.4	670.56	2086.3	2756.8	1.9312	6.7600	6.00
7.00	165.0	1.1080	0.2729	696.44	2572.5	697.22	2066.3	2763.5	1.9922	6.7080	7.00
8.00	170.4	1.1148	0.2404	720.22	2576.8	721.11	2048.0	2769.1	2.0462	6.6628	8.00
9.00	175.4	1.1212	0.2150	741.83	2580.5	742.83	2031.1	2773.9	2.0946	6.6226	9.00
10.0	179.9	1.1273	0.1944	761.68	2583.6	762.81	2015.3	2778.1	2.1387	6.5863	10.0
15.0	198.3	1.1539	0.1318	843.16	2594.5	844.84	1947.3	2792.2	2.3150	6.4448	15.0
20.0	212.4	1.1767	0.09963	906.44	2600.3	908.79	1890.7	2799.5	2.4474	6.3409	20.0
25.0	224.0	1.1973	0.07998	959.11	2603.1	962.11	1841.0	2803.1	2.5547	6.2575	25.0
30.0	233.9	1.2165	0.06668	1004.8	2604.1	1008.4	1795.7	2804.2	2.6457	6.1869	30.0
35.0	242.6	1.2347	0.05707	1045.4	2603.7	1049.8	1753.7	2803.4	2.7253	6.1253	35.0
40.0	250.4	1.2522	0.04978	1082.3	2602.3	1087.3	1714.1	2801.4	2.7964	6.0701	40.0
45.0	257.5	1.2692	0.04406	1116.2	2600.1	1121.9	1676.4	2798.3	2.8610	6.0199	45.0
50.0	264.0	1.2859	0.03944	1147.8	2597.1	1154.2	1640.1	2794.3	2.9202	5.9734	50.0
60.0	275.6	1.3187	0.03244	1205.4	2589.7	1213.4	1571.0	2784.3	3.0267	5.8892	60.0
70.0	285.9	1.3513	0.02737	1257.6	2580.5	1267.0	1505.1	2772.1	3.1211	5.8133	70.0
80.0	295.1	1.3842	0.02352	1305.6	2569.8	1316.6	1441.3	2758.0	3.2068	5.7432	80.0
90.0	303.4	1.4178	0.02048	1350.5	2557.8	1363.3	1378.9	2742.1	3.2858	5.6772	90.0
100.	311.1	1.4524	0.01803	1393.0	2544.4	1407.6	1317.1	2724.7	3.3596	5.6141	100.
110.	318.2	1.4886	0.01599	1433.7	2529.8	1450.1	1255.5	2705.6	3.4295	5.5527	110.
120.	324.8	1.5267	0.01426	1473.0	2513.7	1491.3	1193.6	2684.9	3.4962	5.4924	120.
130.	330.9	1.5671	0.01278	1511.1	2496.1	1531.5	1130.7	2662.2	3.5606	5.4323	130.
140.	336.8	1.6107	0.01149	1548.6	2476.8	1571.1	1066.5	2637.6	3.6232	5.3717	140.
150.	342.2	1.6581	0.01034	1585.6	2455.5	1610.5	1000.0	2610.5	3.6848	5.3098	150.
160.	347.4	1.7107	0.009306	1622.7	2431.7	1650.1	930.6	2580.6	3.7461	5.2455	160.
170.	352.4	1.7702	0.008364	1660.2	2405.0	1690.3	856.9	2547.2	3.8079	5.1777	170.
180.	357.1	1.8397	0.007489	1698.9	2374.3	1732.0	777.1	2509.1	3.8715	5.1044	180.
190.	361.5	1.9243	0.006657	1739.9	2338.1	1776.5	688.0	2464.5	3.9388	5.0228	190.
200.	365.8	2.036	0.005834	1785.6	2293.0	1826.3	583.4	2409.7	4.0139	4.9269	200.
220.9	374.1	3.155	0.003155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298	220.9

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L-4/T-2/ME **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 427** (Applied Engineering Mathematics)

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**.

Symbols have their usual meaning.

1. (a) With a neat sketch, explain the distinguishing features of variational and differential operators. **(17)**

'Variational operator is commutative with differential and integral operators' – explain.

(b) The axial flow velocity v(x, y) in a square duct is given by the stationary value of **(18)**

$$I(v)=\int_{-a}^{a}\int_{-a}^{a}\left[\left(\frac{\partial v}{\partial x}\right)^2+\left(\frac{\partial v}{\partial y}\right)^2+4\alpha v\right]dxdy$$

where α is a constant.

It is known that v = 0 at x = ±a, y = ±a. Mathematically show that the velocity profile across the duct is directly governed by the corresponding Poisson's equation.

2. (a) Describe Galerkin's weighted residual method for obtaining approximate analytical solutions to boundary value problems. Discuss the relative advantages of Galerkin's method over other approximate methods. **(15)**

(b) Suppose you need to find the solution of the cantilever beam shown in Fig. Q. 2(b) by Rayleigh-Ritz method. **(20)**

Justify the suitability of the following polynomial trial functions to determine the solution of the beam.

(i) $y = c_1x^2$

(ii) $y = c_2x^3$

(iii) $y = c_3x^2 + c_4x^3$

Suggest a more appropriate trial solution to the beam.

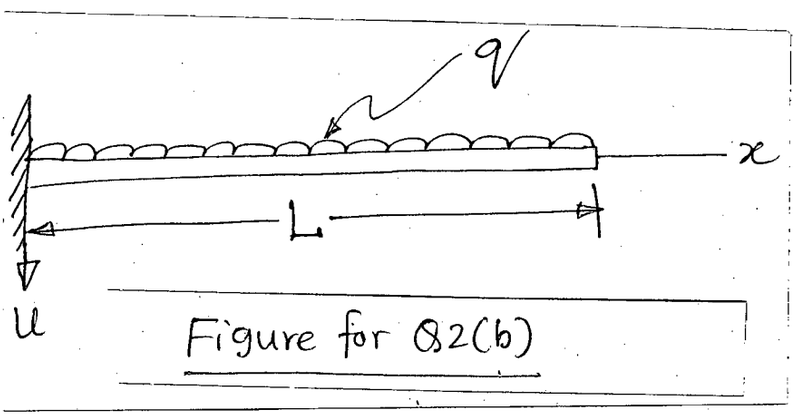

Figure for Q2(b)

Contd P/2

ME 427

3. (a) With neat sketches describe the details of finite elements used to model the plane structural problems. **(17)**

(b) Schematically illustrate the characteristics of a standard quadratic bar element. Show that stress varies linearly over a quadratic bar element. **(18)**

4. (a)

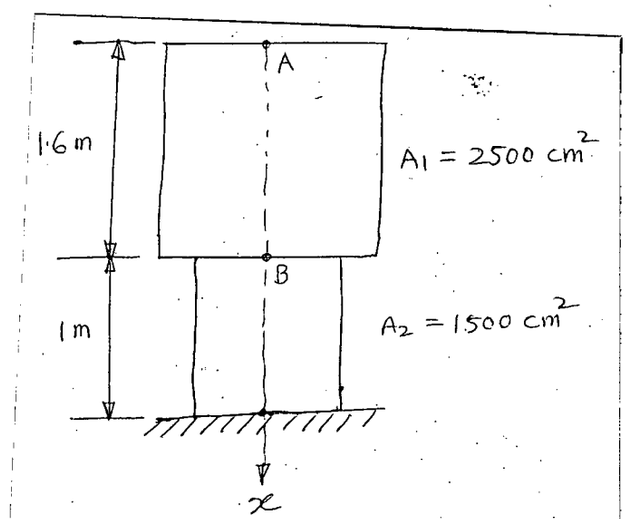

Figure for Q4(a)

For the vertical rod shown find the deflection at A and B. Also find the stress distribution in the rod. Solve the problem using a two-element model of finite element formulation. Use E = 100 MPa and specific weight of the rod as 0.06 N/cm^3. **(18)**

(b)

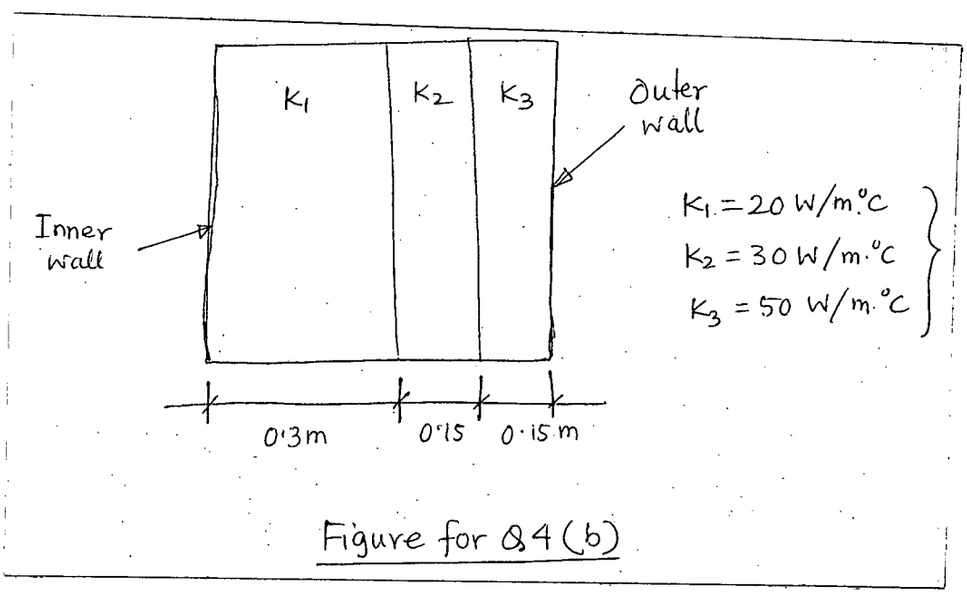

Figure for Q4(b)

The composite wall consists of three material layers as shown in Figure for Q. 4(b). The outer wall temperature is 20°C. convection heat transfer takes place on the inner wall with T_∞ = 800°C and H = 25 W/m^2.°C. Determine the temperature distribution in the wall using FEM. **(17)**

Contd P/3

ME 427

SECTION – B

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

5. (a) The Navier-Stokes equation in 2-D form for the x-component of the velocity vector is given by **(15)**

$$\frac{\partial u}{\partial t} = \frac{-\partial u^2}{\partial x} - \frac{\partial (uv)}{\partial y} - \frac{\partial p}{\partial x} + \frac{1}{R_e}\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right)$$

where v = y-component of velocity

R_e = Raynolds number

(i) Determine the order of the differential equation

(ii) Check whether the equation is linear or non-linear

(iii) Comment on the homogeneity of the differential equation.

(b) Discuss the Dirichlet type and the Newmann type boundary conditions used in boundary value problems. Give suitable examples. **(10)**

(c) Give the physical interpretation of the following set of equations: **(10)**

$$\frac{d^2}{dx^2}\left(EI\frac{d^2y}{dx^2}\right) = W_o\ ; \qquad [0 < x < L]$$

$$[I = I(x)]$$

$$y(0) = 0$$

$$y'(0) = 0$$

$$\left[EI\frac{d^2y}{dx^2}\right]_{x=L} = M_o$$

$$\frac{d}{dx}\left[EI\frac{d^2y}{dx^2}\right]_{x=L} = 0$$

6. (a) What are the factors that make a problem non-linear? Give an example of a non-linear problem along with its governing differential equation. **(12)**

(b) The second order differential equation for displacement of a spring mass system with mass m and spring stiffness k is given by **(23)**

$my + ky = 0$ with $y(0) = 0,\ y'(0) = 0$

(i) Depending on the specific physical condition, comment on the type of the problem.

(ii) Convert the equation into a set of first order differential equations with appropriate initial conditions.

(iii) Find the solution of the problem at t = 0.6 s with step size h = 0.2 using the RK method.

Contd P/4

ME 427

7. (a) Using the modified Newton-Raphson method, find the solution (up to third iteration) of the following non-linear problem. **(17)**

$$x^2 - y^2 = 4$$
$$x^2 + y^2 = 16$$

Consider the starting value of x and y; $x_0 = y_0 = 2.828$.

(b) A simply supported beam of length L carries a linearly varying distributed load that varies from 0 to q N/m as shown in Figure for Q. No. 7(b). **(18)**

(i) Give the differential equation of this beam problem along with the appropriate boundary conditions.

(ii) Discretize the beam into four segments and using the FDM develop the necessary nodal algebraic equations to solve for beam deflection. Also, show the global coefficient matrix for this problem.

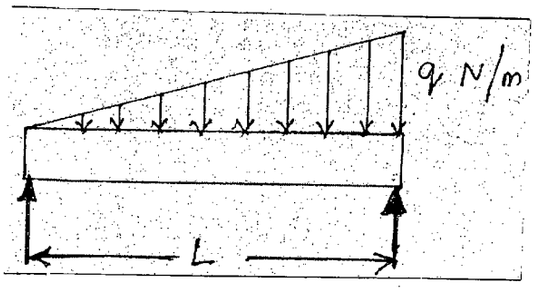

Figure for Q. No. 7 (b)

8. (a) What is finite difference method? Describe the advantages and the limitations of this method. Give an example of a physical problem where the FDM technique is difficult to apply. **(10)**

(b) The axi-symmetric heat conduction equation for a cylinder is given by **(25)**

$$k\left[\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r}\right] + G(r) = 0$$

Consider the case of steady state radial heat conduction through a cylindrical wall with $r_i = 100$ mm and $r_0 = 400$ mm. There is a source of energy generation inside the cylinder that produces heat at a rate of 10 MW/m^3. The outer surface is maintained at 150°C and the inner ambient temperature is 25°C. The heat transfer coefficient for the inner surface is 800 W/m^2 °C and the thermal conductivity of the material is 50 $\frac{W}{mK}$.

Use two equal segments along the radius of the cylinder and follow the finite difference method to calculate the temperature

(i) at the inner surface of the cylinder

(ii) at r = 250 mm.

L-4/T-2/ME Date : 21/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 469** (Nuclear 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**.

Symbols have their usual meanings.

1. (a) Describe with a neat sketch the working principle of PWR. **(15)**

   (b) Describe the differences between BWR and PWR. **(10)**

   (c) What do you mean by fuel pellet? Describe with a sketch the construction of uranium di-oxide fuel element. **(10)**

2. (a) Describe the specific characteristics of Gen III$^+$ PWRS. **(10)**

   (b) What do you mean by decay heat? Describe with sketches and examples. **(15)**

   (c) Write short note on supercritical water-cooled reactor. **(10)**

3. (a) Describe the specific characteristics of a nuclear turbine. How does it differ from a fossil-fuel turbine? **(12)**

   (b) Describe with a sketch, the arrangement of primary system for a 4-loop PWR. **(13)**

   (c) Describe the properties of moderator and reflector materials. **(10)**

4. (a) Describe the mechanism of heat removal from reactor channel. **(5)**

   (b) Write down the heat conduction equation in cylindrical fuel element of a nuclear power reactor with appropriate boundary conditions and discuss. **(10)**

   (c) What do you mean by thermal-hydraulic sub-channel? Show the axial temperature of fuel rod, cladding surface and bulk temperature of coolant as functions of height along coolant channel and discuss. **(11)**

   (d) Write short notes on the following: **(9)**

   (i) DNB and DNBR

   (ii) Breeder Reactor

   (iii) Neutron generation, Moderation and diffusion.

SECTION – B

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

5. Answer the following questions:

   (a) What do you mean by "ionizing radiation"? Give three examples of ionizing radiation. What are the three basic principles of radiation protection? **(7)**

   (b) Mention the SI units of absorbed and effective doses, explain their physical meanings and show how they relate to each other. Give the values of Weighting Factor for different types of radiation. **(8)**

Contd P/2

ME 469

Contd ... Q. No. 5

(c) What is Nuclear Fuel Cycle (NFC)? What are the major parts of NFC? With a ladled diagram show the components of the NFC. **(10)**

(d) What is Radioactive Waste? What do you mean by Radioactive Waste Management? Explain the categorization of the Radioactive Wastes and give example for each of the categories. **(10)**

6. Answer the following questions:

(a) During a startup, a reactor has a stable doubling time of 170 seconds. Calculate the reactor period. **(10)**

(b) The total neutron flux in a shutdown reactor is constant at 7.0×10^3 n/cm^2-sec. If non-fission neutron sources are supplying a constant flux of 1.5×10^3 n/cm^2-sec, then calculate the value of K_{eff}. **(10)**

(c) What do you mean by Reactor Kinetics (2)? Derive the following equation using basic reactor kinetics principles: **(12)**

$N = N_o e^{t/\tau}$ (the symbols used have their usual meanings).

(d) Define reactivity. What is prompt critically? Is prompt critically a common situation in normal operation of power reactors? **(3)**

7. Answer the following questions:

(a) Calculate the number of fissions per second that occurs in a 300 $MW_{thermal}$ Uranium fuelled reactor. **(8)**

(b) Calculate the amount of energy released by complete burning of 1g of U-235. **(10)**

(c) Write down the six factor formula and briefly describe each terms. **(11)**

(d) Draw the neutron energy vs fission cross-section curve for U-235 and describe it briefly. **(6)**

8. Answer the following questions:

(a) With the help of schematic diagram explain (i) Prompt neutron lifetime and generation time and (ii) Delayed neutron lifetime and generation time. **(8)**

(b) What do you mean by Xe-poisoning? Explain Xe-poisoning with the help of relevant diagram(s). **(12)**

(c) Briefly narrate the meaning of (i) albedo, (ii) core excess, (iii) shutdown margin and (iv) control rod worth. **(10)**

(d) What do you mean by microscopic and macroscopic cross-sections? Write down the units of these two types of cross-sections. **(5)**

L-4/T-2/ME **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 433** (Fluidics)

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) What do you mean by fluidic devices? What are the advantages of fluidic devices over their electric counterparts? **(9)**

   (b) What are the major types of the fluid logic control devices? Compare their merits and demerits. **(8)**

   (c) What is Coanda Effect? Explain with neat sketches how the effect is applied in development of a wall attachment flip-flop. **(9)**

   (d) Discuss the working principle of (i) Turbulence amplifier and (ii) Vortex flow amplifier. **(9)**

2. (a) What are the meanings of the symbols shown in Figure for Q. 2(a)? **(6)**

   (b) What is ladder diagram? Discuss the operation of the dual cylinder sequencing circuit shown in Figure for Q. 2(b) and interpret the ladder diagram. **(18)**

   (c) Identify different components and narrate the operation of the circuit shown in Figure for Q. 2(c). Discuss the characteristic features of this circuit. **(11)**

3. (a) What does the circuit of Figure for Q. 3(a) accomplish when the manual shutoff value V_1 is opened? Describe its operation. **(15)**

   (b) What are meter-in and meter-out circuits? Discuss their application areas. **(10)**

   (c) Draw the symbol of a 4 way, 3 position, spring centered, solenoid actuated proportional directional control valve. Consider tandem flow path for centre position. **(10)**

4. (a) A downstream pressure of the 53% of the upstream pressure is the limiting factor for passing air through a pneumatic valve to an actuator. Why? **(6)**

   (b) Draw a regenerative hydraulic circuit to operate a 4 way, 3 position, spring centered, solenoid actuated, closed center double acting cylinder. Explain its merits, demerits and probable fields of applications. **(12)**

   (c) It is required to design a hydraulic circuit to operate a machine tool which needs low speed and high load during the machining operation. Otherwise it moves practically at nearly zero load. What kind of circuit will you recommend for this application? Why? Draw the circuit. **(17)**

Contd P/2

ME 433

SECTION – B

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

5. (a) Describe the operating principle of a lobe pump. How does it differ from the external gear pump? **(10)**

   (b) Name the various types of hydraulic cylinder mountings and mechanical linkages for transmitting power and show their schematic (Any ten). Also write the benefits of their use. **(10)**

   (c) Describe the purpose, construction and operation of hydraulic shock absorbers. **(15)**

6. (a) Write the advantages of hydrostatic transmission system. **(5)**

   (b) A hydraulic motor has volumetric efficiency of 90% and operates at a speed of 1800 rpm and a pressure of 1000 psi. If the actual flow rate consumed by the motor is 80 gpm and the actual torque delivered by the motor is 1350 in.lb, find the overall efficiency of the motor. **(15)**

   (c) What is directional control valve? With necessary schematic describe the construction and operation of a four-way directional control valve. Also show the graphic symbol and flow directions in this valve. **(15)**

7. (a) Write short notes on (i) Shuttle valve (ii) Unloading valve (iii) Counterbalance valve. **(15)**

   (b) Show the calculation of the power loss in pressure relief and unloading valves with typical numerical values. **(5)**

   (c) With neat sketches, describe the operation of compound pressure relief valve and differentiate with pressure reducing valve. **(15)**

8. (a) Describe the purpose, construction and operation of electrohydraulic servo valve and differentiate it with mechanical-hydraulic valve. **(15)**

   (b) Describe the advantages of using cartridge valves. **(5)**

   (c) A needle valve is used to control the extending speed of a hydraulic cylinder as shown in Fig. for Q. No. 8(c). The needle valve is placed in the outlet line of the hydraulic cylinder as shown. The following data are given: **(15)**

   (i) Desired cylinder speed = 10 in/s

   (ii) Cylinder piston diameter = 2 in.

   (iii) Cylinder rod diameter = 1 in.

   (iv) Specific gravity of oil = 0.9

   (v) Pressure relief valve setting = 550 psi

   (vi) Capacity coefficient of the needle valve = 0.4 gpm/$(psi)^{1/2}$

   Determine the load on the cylinder.

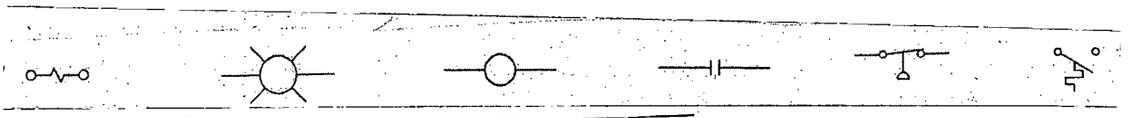

Figure for Q2.a

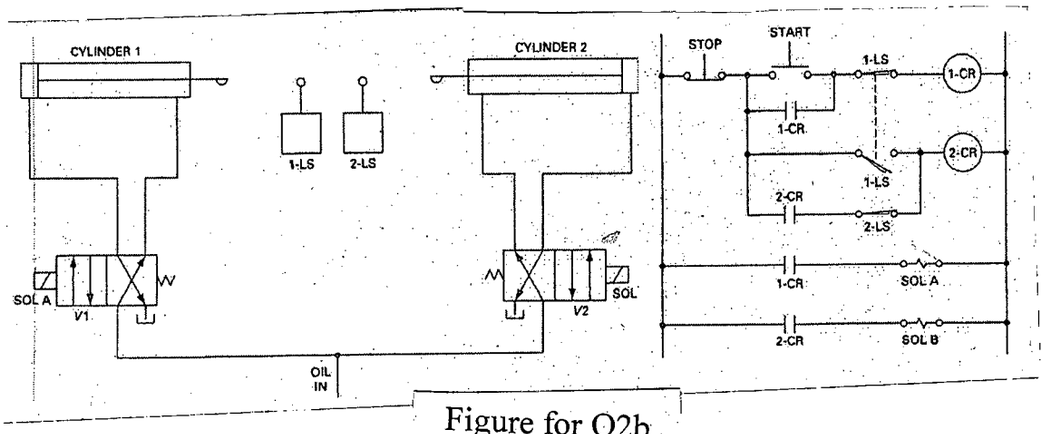

Figure for Q2b

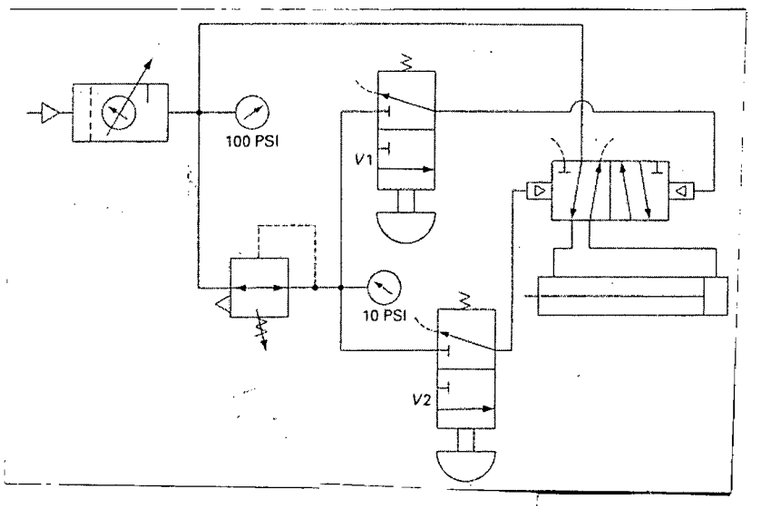

Figure for Q2.c

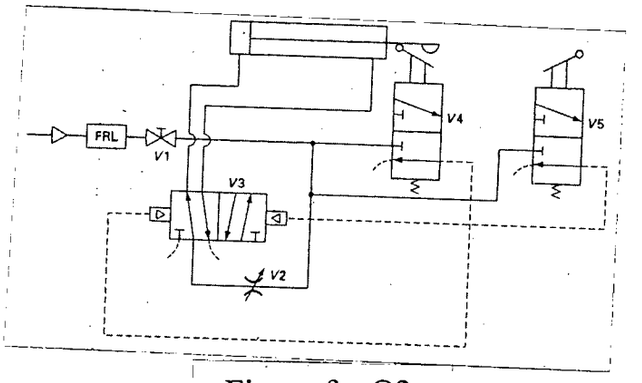

Figure for Q3a

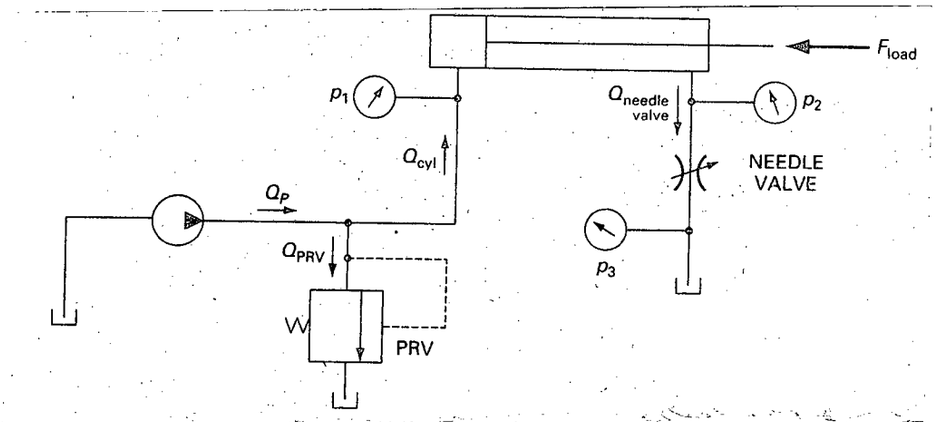

Fig. for Q. No. 8(c)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 409** (Renewable Energy)

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**.

Assume a reasonable value for any missing data.

All the symbols have their usual meaning.

1. (a) Write a short note on Enhanced Geothermal System (EGS). Discuss its advantage and challenges. **(10)**

   (b) Estimate the minimum mass of hot dry rock needed to produce 1000 MW_e-yr of electricity assuming that the rock mass is solid granite with a density of 2500 kg/m^3 and a heat capacity of 1000 J/kg.K at an initial temperature of 250°C. An ambient temperature of 25°C can be assumed. **(13)**

   [Hint: $Q_i = A_i \left[\phi \rho_f C_{p,f} + (1-\phi) \Pr C_{p,r}\right] \nabla T_i \frac{z^2}{2}$]

   (c) Describe the working principle of a double flash steam power plant. **(12)**

2. (a) With the help of a schematic diagram, describe the working principle of a floating dome type biogas plant. **(15)**

   (b) How much electricity can be produced from the cowdung of four cows? Assume a reasonable value for all the steps in your calculations. **(10)**

   (c) Draw the flow chart of biodiesel production from sunflower oil in batch process. **(10)**

3. (a) Determine the monthly mean daily insolation in Dhaka on a south facing flat plate solar collector tilted upwards at an angle equal to the latitude (23.7° N), during April. Ground reflectance is estimated as 0.2. **(20)**

   (b) Write a short note on parabolic dish type solar collector. Compare parabolic dish type solar collector with Trough type solar collector. **(15)**

4. (a) Compare different storage technology that can be employed for Renewable energy storage. **(10)**

   (b) Why life cycle analysis is important for renewable energy technology? Describe the life cycle analysis of a PV solar cell with assumed value. **(13)**

   (c) With neat sketches show three different techniques to harvest solar energy for room heating. **(12)**

Contd P/2

ME 409

SECTION – B

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

5. (a) Write down "True" or "False" for each of the following statements. Do not write the whole sentences, one is done for you as an example: **(5×1=5)**

(i) Betz limit for wind energy extraction is 16/27.

Ans: (i) True.

(ii) For Kaplan and Pelton turbines design ranges are: $2 < H < 40$ and $50 < H < 1300$ respectively, where H = head in meters.

(iii) For Francis and Turgo turbines design ranges are: $50 < H < 350$ and $50 < H < 250$ respectively.

(iv) Hydropower developed in MW for Bangladesh, Bhutan and Nepal are : 469, 218 and 627 respectively.

(v) An OTEC system can produce a maximum Carnot Efficiency of about 6.7%.

(vi) In 1993, an OTEC plant in Keyhole point, Hawaii produced 47 kilowatts of electricity which broke the record of 40 kilowatts set by a Japanese system in 1982.

(b) Fill in the blanks with appropriate words or/and values to complete the following statements: **(5×2=10)**

(i) OTEC is an energy technology that converts _____ _____ to _____ _____.

(ii) An OTEC system can produce power as long as temperature between the _____ _____ _____ and _____ _____ _____ differs by about _____.

(iii) Half of the earth's incoming solar energy is absorbed between the _____ _____ and the _____ _____ _____.

(vi) Largest airplane wingspan and largest wind turbine rotor _____ _____ _____ _____ _____.

(v) Wind power increases by 0.43% for every 1% _____ _____ _____ _____ _____.

(c) Classify various hydropower installations in terms of their scale of power production. With neat sketches and labelling, show how those turbine are used for power plants of (i) low, (ii) medium and (iii) high head hydroelectric installations. **(20)**

6. (a) Summarise the arguments "in favour of" and "against" the construction of a dam for a large scale hydro power plant regarding the following issues. **(2×2×5=20)**

(i) Cost

(ii) Environment

(iii) Flood control

(iv) Navigation

(v) Resettlement

Contd P/3

ME 409

(b) A hydro power plant uses a mountain stream with an effective head of 25 meters and a flow rate of 6 m^3 per minute. Assuming plant efficiency = 81.56% and energy consumption per person = 2500 kwh, determine the following: **(15)**

(i) Power generated by the plant

(ii) Number of people supported by the plant

7. (a) Identify the terms, with examples for the nameplate power rating of a wind turbine unit represented by: **(10)**

$$P_r = COP\ \rho\ A \frac{v_r^3}{2} \times 10^{-3}$$

(b) Draw a typical Generic Wind Turbine performance curve with variable pitch blades. **(10)**

(c) What fraction of time will a wind turbine having a cut-in wind velocity of 4 m/s be non-rotational in a wind field having a Rayleigh velocity distribution with a most probable speed of 6.4 m/s? **(15)**

8. (a) How waves are formed in an ocean and what is the cause of additional wave growth? What are the 3 basic systems for ocean wave energy devices? **(10)**

(b) With some relevant data and information, describe how much ocean energy could be extracted in the Bay of Bengal from a single unit. **(10)**

(c) Considering a sinusoidal ocean wave with crest-to-trough height "h" and wavelength "λ", draw and label the schematic diagram for estimation of wave potential energy. **(15)**

Equations for Solar insolation calculation:

1. $\Delta = 23.45 \sin [360 \times (284 + n)/365]$

2. $h = \frac{2\Omega_{SS}}{15} = \frac{2}{15} (-\tan \Delta \tan L)$

3. $G_O = G_{SC} [1 + 0.033 \cos 360n/365] \cos \theta_z$

4. $H_o = \frac{24}{\pi} \times 3600 G_{SC} [1 + 0.033 \cos(360\ n/365)]$

   $\times [\cos L \cos \Delta \sin \Omega_{SS} + \frac{2\pi\Omega_{SS}}{360} \cdot \sin L \sin \Delta]$

5. $\overline{K}_T = \overline{H}/\overline{H}_o$

6. $\frac{\overline{H}_d}{\overline{H}} = 0.775 + 0.00653 (\Omega_{SS} - 90)$

   $- [0.505 + 0.00455 (\Omega_{SS} - 90)] \cos (115\ K_T - 103)$

7. $\overline{R}_b = \frac{\cos L^* \cos \Delta \sin \Omega_{ST} + (\pi/180)\ \Omega_{ST} \sin L^* \sin \Delta}{\cos L \cos \Delta \sin \Omega_{SS} + (\pi/180)\ \Omega_{SS} \sin L \sin \Delta}$

8. $\overline{H}_T = (\overline{H} - \overline{H}_d)\ \overline{R}_b + \overline{H}_d \frac{(1 + \cos \beta)}{2} + \rho \frac{(1 - \cos \beta)}{2}$

Table-1: Day Number for Monthly Means

Month	date	day number (n)
January	17	17
February	16	47
March	16	75
April	15	105
May	15	135
June	11	162
July	17	198
August	16	228
September	15	258
October	15	288
November	14	318
December	10	334

L-4/T-2/ME Date : 26/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 467** (Automobile 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) What do you understand by a "Single Wire Electric System" used in a vehicle? **(6)**

   (b) What is the function of a typical "Oxygen Sensor" used in an automobile? Briefly explain how it works. **(10)**

   (c) What is the function of an "Overrunning Clutch" in the starting system of an automobile? Briefly explain. **(10)**

   (d) Write a brief note on MIL shown on the dashboard. **(9)**

2. (a) Define dedicated and retrofitted NGVs. What proportion of the vehicle population in the world are NGVs? **(7)**

   (b) A CNG cylinder is specified as Type-2 and 90 WL – what does they mean? Compare the energy storage capacity of a CNG cylinder with respect to petrol tank volume. **(10)**

   (c) What is the function of a pressure regulator? Briefly explain how a typical 3-stage CNG pressure regulator works. **(10)**

   (d) Why do we need an "Emulator" in some retrofitted CNG vehicles? **(8)**

3. (a) Why does the specific gravity of the electrolyte of an automotive battery change with its charge condition? Briefly explain. **(8)**

   (b) AN electric charge indicator on the dashboard remains illuminated after starting the engine of a vehicle – state two possible reasons for which this could occur. **(8)**

   (c) Briefly explain the common methods practiced for refrigerant leakage detection in a car air conditioning system. **(10)**

   (d) What is the function of a "Filter-Drier"? Where is it located on a car A/C circuit? **(9)**

4. (a) What is "Overturning Speed"? Deduce an expression of overturning velocity of a typical vehicle while taking a turn. **(10)**

   (b) A vehicle weighing 1.2 tons is running at a speed of 80 kh/h. Calculate the safe radius of taking a turn on a highway without overturning if the track width is 1.5 m and CG. is 0.7 m above road contact. **(9)**

   (c) Briefly explain why the front of a car goes down and the back lifts up during braking. What type of vehicle motion is this termed as? **(10)**

   (d) Distinguish between vehicle identification number and registration number. **(6)**

Contd P/2

ME 467

SECTION – B

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

5. (a) What are the functions of a clutch in a car with manual transmission? Describe the construction of a clutch with sketches of all its major components. **(12)**

   (b) Explain how synchronization work inside a manual transmission gearbox. What is a transaxle? **(8)**

   (c) Mention the advantages of 4WD/AWD drivetrains over 2WD (FWD or RWD) drivetrain. What is final drive? **(6)**

   (d) What are the design considerations to be made for the construction of a propeller shaft? Show with simple sketches, the construction of a two-piece propeller shaft with different types of joints. **(9)**

6. (a) With necessary schematic diagrams, make a comparison between 'Rack and Pinion' and 'Pitman Arm' steering systems. **(12)**

   (b) State how 'camber' and 'caster' affect the steering stability, directional control, road grip, traction, tire wear, wheel returnability and steering force of a vehicle. **(10)**

   (c) Describe the construction of a typical automotive tire. List the advantages of a radial tire construction. **(8)**

   (d) What are the benefits of using tubeless tires? **(5)**

7. (a) What happens to the kinetic energy of a moving vehicle when brakes are applied to stop it? Which factors should be considered to calculate the braking force required to stop the vehicle and the stopping distance of the vehicle? **(10)**

   (b) With a schematic diagram describe the construction and operation of a power assisted braking system. **(10)**

   (c) What are the main components of a suspension system? Mention the names of two of the possible arrangements of these components for each of front and rear suspension system. **(5)**

   (d) Why are shock absorbers used in a suspension system? Show the construction and operation of a shock absorber. **(10)**

8. (a) What is an overdrive? Why is it used? **(3)**

   (b) What are sprung-weight and unsprung-weight of a vehicle? Why are they important? **(5)**

   (c) Write short notes on the following (any three): **(27)**

   (i) Torque Converter

   (ii) Simple Planetary Gearbox

   (iii) Limited Slip Differential

   (iv) McPherson-Strut front suspension

L-4/T-2/ME **Date : 30/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 475** (Mechatronics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meaning.

Assume reasonable values for any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Explain the operating principle of a positive and a negative half-wave rectifiers. **(10)**

   (b) Draw the logic circuit for the Boolean equation **(10)**

   (i) $X = (A + B)\overline{B} + \overline{B} + BC$

   (ii) $X = \overline{AB} \cdot \overline{B + C}$

   Simplify the equation and draw the simplified logic circuit.

   (c) Write short notes on: (any three) **(15)**

   (i) 4 bit full adder circuit

   (ii) DeMorgan's theorem

   (iii) Switch bounce and de-bouncing circuit

   (iv) Divide by-8 circuit

2. (a) Classify filters. Draw the characteristics curve of different filters. **(5)**

   (b) Draw a circuit diagram to implement PI controller using op-amps. Derive the expressions of K_P and K_I in terms of resistance and capacitance. **(10)**

   (c) A 10-bit ADC has a reference voltage of 5.0 V and analog input of 3.0 V. Find the binary output. **(5)**

   (d) Write short notes on: (any three) **(15)**

   (i) ADC throughput

   (ii) SA-ADC

   (iii) R-2R Ladder DAC

   (iv) Asynchronous serial communication

3. (a) Define piezoresistive effect and gage factor. Derive the expression for the gage factor of a strain gage. **(15)**

   (b) Describe an appropriate sensor used to measure differential pressure. **(5)**

   (c) Write down the applications of hall effect sensor. **(5)**

   (d) Compare different types of actuators used in Mechatronics systems. **(10)**

Contd P/2

ME 475

4. (a) Classify robot manipulators. What are the different motions associated with manipulator joints? **(10)**

   (b) What are the advantages and disadvantages of lead through robot programming? **(10)**

   (c) Write short notes on: (any three) **(15)**

   (i) Instruction Codes

   (ii) ROM

   (iii) Harvard and Von Neuman computer

   (iv) Registers in microprocessor.

SECTION – B

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

5. (a) Define Mechatronics. Show the relationship between Mechatronics and other branches of engineering. **(10)**

   (b) For the liquid-level control system as shown below write down the transfer function both during filling up of the tank and during emptying the tank. Identify the type of control system used here. **(10)**

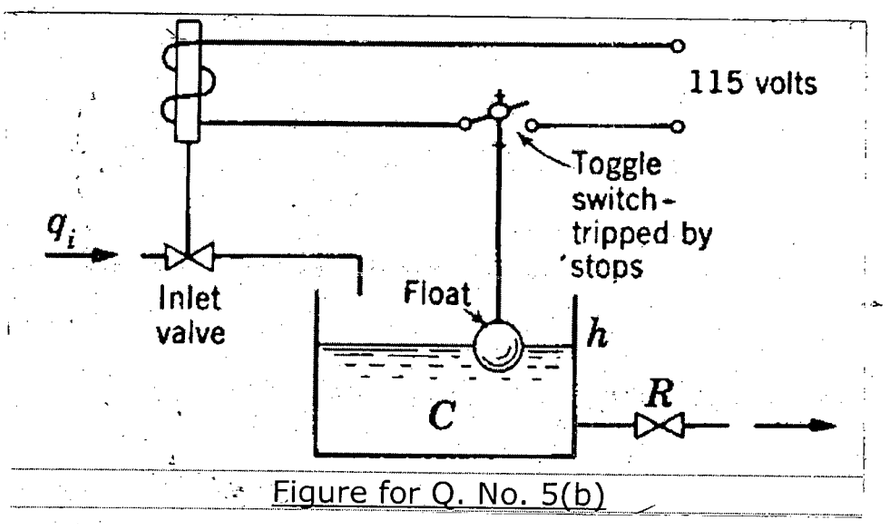

Figure for Q. No. 5(b)

   (c) Draw the typical time response curve of a second order system for step input and define the following terms: **(15)**

   (i) Peak time

   (ii) Rise time

   (iii) Settling time

Prove that the settling time of a second order system under step input is given by $T_s \approx 4/\zeta\omega_n$, where ζ is damping ratio and ω_n is undamped natural frequency.

Contd P/3

ME 475

6. (a) Define 'poles' and 'zeros' of a transfer function. For the transfer function **(10)**

$$G(s) = \frac{36}{s^2 + 4.2s + 36}$$

indicate the poles in the s-plane. Also find the natural frequency and damping ratio. Draw the corresponding step response curve and state the kind of response expected.

(b) What are the essential conditions for studying the stability of a control system. Using Routh-Hurwitz criterion, determine the stability of a system with the following characteristics equations: $G(s) = s^5 + 7s^4 + 6s^3 + 42s^2 + 8s + 56$. **(15)**

(c) Derive the response of a first order system for harmonic input and hence deduce the expression of amplitude ratio and phase angle. **(10)**

7. (a) What are the key components of machine vision system? Describe the processing steps of machine vision system. **(10)**

(b) What are the main reasons for industrial automation? Mention some applications where manual labor is preferred over automation? **(10)**

(c) With a block diagram, show the design process before and after involvement of CAD. **(10)**

(d) Write short notes on "virtual prototyping". **(5)**

8. (a) Draw the step response of a PI, PD and PID controller. Hence, define the term integral time and derivative time. **(10)**

(b) For a spring-mass-damper system shown in Figure, derive the transfer function of the system after implementing a simple P controller and hence, show that "a P controller always has a permanent control deviation of offset". **(15)**

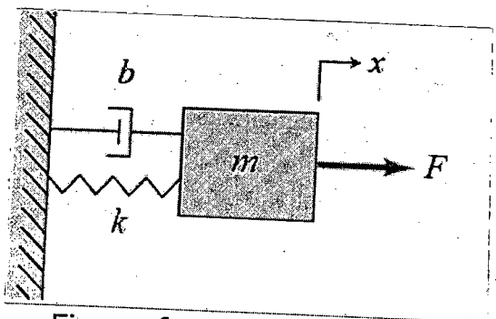

Figure for Q. No. 8(b)

(c) Classify feedback control system. With functional block diagram, explain the control system involved in home heating system. **(10)**

L-4/T-2/ME Date : 30/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 413** (Energy and Environment)

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) Define Ecosystem. With the help of simple schematic, explain how energy flows in ecosystems. **(10)**

   (b) How would you distinguish between Proven, Probable and Possible fossil fuel reserves? Why are reserve estimates usually revised? **(12)**

   (c) What are the factors that need to be achieved to meet the future energy need in a sustainable manner? **(5)**

   (d) For a 'Proven Developed Reserve' of oil, the estimated cumulative production of oil over a reserve-life of 30 years is 75 million barrels. If the initial production rate was 3 million barrel/year, estimate the yearly production rate in the 18^{th} year. **(8)**

2. (a) What are the two main groups of particulate matters? Explain the way these different groups of particulate matters are formed and how they affect human health. **(8)**

   (b) What do you understand by bad ozone and good ozone? With the help of suitable diagrams, explain the mechanisms of formation and depletion of ozone layer. **(15)**

   (c) Apart from their effect on human health and life, air pollutants can cause harmful effects on materials, atmospheric properties and vegetation – how? **(12)**

3. (a) What are the different facility-oriented air pollution control measures? Why is the control of secondary air pollutants more difficult than the primary pollutants? **(10)**

   (b) Describe, with the help of suitable diagrams, the working principle of any control method for particulate pollutants. What are its advantages compared to the other control techniques used for particulate pollutants? **(17)**

   (c) What factors affect the dust collection efficiency of electrostatic precipitators? How? **(8)**

4. (a) What extreme weather events are likely/very likely to occur in the future according to the predicted future effects of global warming? **(5)**

   (b) What, according to you, are the main reasons behind the lack of success of the Kyoto Protocol? **(5)**

Contd P/2

ME 413

Contd ... Q. No. 4

(c) Describe ice core measurement method of greenhouse gas. What information can be obtained from the ice core measurement method of greenhouse gases? **(15)**

(d) What factors would you consider for evaluating the performance of an energy storage system? In that respect, what are the limitations of traditional lead-acid or lithium-ion battery systems? **(10)**

SECTION – B

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

5. (a) Classify energy resources. **(8)**

   (b) Write the impacts of industrial motor on energy efficiency. **(7)**

   (c) Give some ideas of reducing power consumption in compressed air system. **(8)**

   (d) How can the energy losses be minimized in Automobiles? **(12)**

6. (a) What are the barriers to the use of renewable energy? **(12)**

   (b) With the help of a schematic diagram describe solar tower system. **(13)**

   (c) Write the social impacts of solar power. **(10)**

7. (a) What are the technical drawbacks of wind power farms? **(8)**

   (b) Write the positive and negative sides of hydropower. **(15)**

   (c) With the help of a schematic diagram, describe the hydro power plant. **(12)**

8. (a) What do you understand by Green-buildings, Zero-energy buildings and Zero-carbon buildings? **(8)**

   (b) Write the advantages and disadvantages of rain water harvesting. **(12)**

   (c) With the help of a schematic diagram, describe grey water conservation practice for energy efficient building concept. **(15)**

L-4/T-2/ME Date : 30/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **ME 449** (Composite Materials)

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) Derive the fully inverted form of the stiffness matrix of a laminate in terms of the matrices [A], [B] and [D], where the symbols have their usual meaning. **(15)**

   (b) Consider a four ply laminate with stacking sequence [+45/–45]s. Evaluate the [A], [B] and [D] matrices of the laminate if each lamina has a thickness of 3 mm and the following orthotropic stiffness matrix: **(20)**

$$[Q]=\begin{bmatrix} 20 & 0.7 & 0 \\ & 2.0 & 0 \\ \text{sym} & & 0.7 \end{bmatrix} \text{ GPa}$$

2. (a) Using the mechanics of materials approach, derive the expression for the inter-laminar shear stress in a laminated beam. **(15)**

   (b) Calculate the flexural modulus of a laminated beam with stacking sequence of [90/0]s. The ply moduli are $E_1 = 50$ GPa and $E_2 = 10$ GPa. Assume ply thickness of 0.5 mm. **(10)**

   (c) Find the inter-laminar shear stress for the laminated beam in part Q. 2(b) at the core and at the outer surface for a given shear load of 200 N, and width b = 20 mm. **(10)**

3. (a) Define 'ineffective length' (L_I) for an aligned discontinuous fiber reinforced composite. Derive an expression for average fiber stress in terms of L_I. **(15)**

   (b) A composite is fabricated of glass fibers with diameters of 0.03 mm in an epoxy resin matrix. All the fibers are aligned parallel to the direction of load application. The volume fraction of fibers is 40%. Assume that the matrix behaves as a rigid-plastic material with a yield strength of 30 MPa and that $E_f = 80$ GPa and $E_m = 3.5$ GPa. Determine the ineffective length for a composite stress of 200 MPa in the fiber direction. Assuming, that the ultimate strength of the fibers is 1.4 GPa, calculate the critical fiber length. **(20)**

4. (a) Define following configurations of laminates with examples – angle ply laminates, quasi-isotropic laminate, antisymmetric laminate. **(15)**

Contd P/2

ME 449

Contd ... Q. No. 4

(b) A 12.5 mm thick plate of glass fiber-epoxy composite with an initial moisture content of 0.5% is exposed on both sides to air at 25°C and 90% relative humidity. Estimate the time required to reach 1% moisture content within the plate. For the composite at 25°C, assume mass diffusivity $D = 2.6 \times 10^{-7}$ mm^2/s. Use the following relation for moisture weight gain as a function of time: **(20)**

$$G = \frac{M - M_i}{M_m - M_i} = 1 - \frac{\delta}{\pi^2} \exp\left(-\frac{\pi^2 Dt}{h^2}\right)$$

where symbols have their usual meaning.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Symbols indicate their usual meaning. Assume any missing data.

5. (a) (i) Explain the effect of fiber size on fiber strength. **(5)**

(ii) Discuss the differences between orthotropic and anisotropic materials. **(5)**

(iii) Write some key distinguishing features of matrix and reinforcements. **(5)**

(b) Outline the manufacturing principle of polymer matrix composites by compression molding and resin transfer molding (RTM). Discuss their relative advantages over each other. **(20)**

6. (a) A uniaxial load is applied to a 10° ply. The linear stress-strain curve along the line of load is related as $\sigma_x = 123\varepsilon_x$, where the stress is measured in GPa and strain in m/m. Given $E_1 = 180$ GPa, $E_2 = 10$ GPa and $\nu_{12} = 0.25$, find the value of (i) shear modulus G_{12} and (ii) modulus E_x for a 60° ply. **(15)**

(b) For a graphite/epoxy unidirectional lamina (Fig. 6(b)), the engineering elastic constants are $E_1 = 181$ GPa, $E_2 = 10.3$ GPa, $\nu_{12} = 0.28$, and $G_{12} = 7.17$ GPa. Find the (i) compliance matrix, (ii) minor Poisson's ratio, (iii) reduced stiffness matrix, (iv) strains in the 1-2 coordinate system. **(20)**

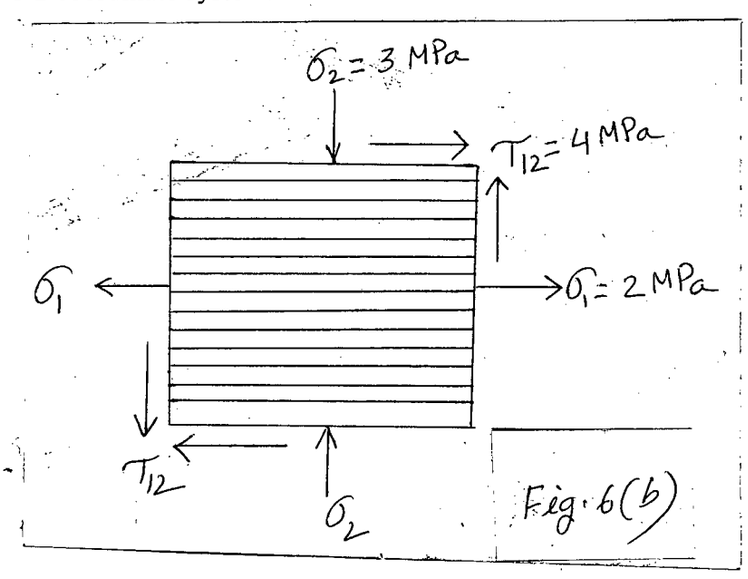

Fig. 6(b)

Contd P/3

ME 449

7. (a) Based on the mechanics of materials approach, derive the expression for transverse Young's modulus of an orthotropic lamina. **(15)**

   (b) A glass/epoxy unidirectional composite lamina has the constituent properties of $G_f = 35.42$ GPa and $G_m = 1.308$ GPa. Assume that the fibers are circular and are packed in a square array. Compute the in-plane shear modulus of the lamina by (i) Halpin-Tsai equations and (ii) mechanics of materials approach. Use maximum possible fiber volume fraction for circular fibers in square array. **(20)**

8. (a) In an aligned and continuous glass fiber reinforced nylon 6,6 matrix composite, the fibers are to carry 94% of a load applied in the longitudinal direction. The modulus and strength of the constituent materials are $E_{fl} = 72.5$ GPa, $E_m = 3$ GPa, $S_{fl}^{(+)} = 3400$ MPa, and $S_{ml}^{(+)} = 76$ MPa. **(15)**

   (i) Determine the volume fraction of fibers necessary.

   (ii) What will be the tensile strength of the composite? Assume the matrix stress at the fiber failure is 30 MPa.

   (b) Using the maximum stress failure theory, find the off-axis shear strength of a 60° graphite/epoxy lamina. Use following properties of the lamina. $S_L^{(+)} = 1500$ MPa, $S_T^{(+)} = 40$ MPa, $S_{LT} = 68$ MPa, $S_L^{(-)} = 1500$ MPa, $S_T^{(-)} = 246$ MPa. **(20)**

L-4/T-2/ME Date : 04/02/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **IPE 481** (Industrial Management)

Full Marks : 280 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) Differentiate product and period costs with examples. Write short notes on manufacturing and non-manufacturing costs. **(6+10)**

(b) Explain the significance of the analysis of mixed costs. **($8\frac{2}{3}$)**

(c) Company M manufactures a wide range of products at several plant locations. The plant in Dhaka, which manufactures home appliances, has been experiencing difficulties with fluctuating monthly overhead costs. The fluctuations have made it difficult to estimate the level of overhead costs that will be incurred for any one month. Management wants to be able to estimate overhead costs accurately in order to better plan its operational and financial needs. The company have identified that overhead costs in the plant in Dhaka tends to vary with machine hours. They want to analyze the behavior of overhead costs with respect to machine hours. Data on machine hours and associated overhead costs for the last year are given below: **(22)**

Month	Machine Hours	Overhead Costs
January	22,450	$86,000
February	26,000	98,900
March	32,450	120,500
April	35,100	137,000
May	43,460	187,500
June	20,500	77,500
July	12,380	69,500
August	31,590	119,500
September	45,870	210,900
October	27,900	107,000
November	10,670	65,500
December	39,600	160,000

(i) Using the least-square method, determine the cost formula for overhead costs of the plant in Dhaka.

(ii) For any one month, machine hours in the plant in Dhaka are estimated to be 49,600 hours. What will be the expected overhead costs?

Contd P/2

IPE 481/ME

2. (a) Angie Silva has recently opened The Sandal Shop, a store that specializes in fashionable sandals. Angie has just received degree in business from state university, and she is anxious to apply principles she has learned to her business. In time, she hopes to open a chain of sandal shops. As a first step, she has prepared the following analysis for her new store: **(36 2/3)**

Selling Price per pair of sandals	$40
Variable expense per pair of sandals	$16
Fixed expenses per year:	
Building rental	$15,000
Equipment depreciation	$7,000
Selling	$20,000
Administrative	$18,000

(i) How many pairs of sandals must be sold each year to break even? What does this represent in total dollar sales?

(ii) Prepare a CPV graph for the store from a zero level of activity up to 5,000 pairs of sandals sold each year. Indicate the break-even point in the graph.

(iii) Angie has decided that she must earn at least $18,000 for the first year to justify her time and effort. How many pairs of sandals must be sold to reach the targeted profit?

(iv) Angie now has two salesperson working in the store – one full time and one part time. It will cost her an additional $8,000 per year to convert the part-time position to a full-time position. Angie believes that the change would bring in an additional $25,000 in sales each year. Should she convert the position?

(v) Refer to the original data, during the first year, the store sales 3,000 pairs of sandals. Determine the net income and store's degree of operating leverage.

(vi) A customer has offered to make a bulk purchase of 1000 pairs per month on a special price basis. Variable expense of $1 could be avoided in this sale. What price should Angie offer to the customer to make an overall net income of $30,000 as a whole? (normal sales would not be affected by this order and assume amount of normal sales as in part (v)).

(b) Explain the importance of CVP analysis. **(10)**

3. (a) Write short note on 'Time value of money'. **(6)**

(b) The company G prepares its master budget on a quarterly basis. The following data have been estimated to assist in preparation of the master budget for the first quarter of 2016: **(40 2/3)**

– As of December 2015, the company's general ledger showed the following account balance:

	Debits	**Credits**
Cash	$48,000	
Accounts Receivables	$224,000	
Inventory	$60,000	
Plant and Equipment	$370,000	
Accounts Payable		$93,000
Capital Stock		$500,000
Retained Earnings		$109,000
	$702,000	**$702,000**

Contd P/3

IPE 481/ME

Contd ... Q. No. 3(b)

– Actual sales for December and budgeted sales for the next four months are as follows:

December	$280,000
January	$400,000
February	$600,000
March	$300,000
April	$200,000

– Sales are 20% for cash and 80% on credit. Payments are collected in the following month of sales. Accounts receivables at December 31 are a result of December credit sales.

– The company's gross profit rate is 40% of sales.

– Monthly expenses are budgeted as follows: salaries and wages, $27,000 per month; advertising, $70,000 per month; freight-out, 5% of sales; depreciation, $14,000 per month; other expenses, 3% of sales.

– At the end of each month, inventory is to be on hand equal to 25% of the following month's sales needs, stated at cost.

– 50% of a month's inventory purchase is paid for in the month of purchase; the other 50% is paid for in the following month.

– During February, the company will purchase a new copy machine for $1,700 cash. During March, other equipment will be purchased for cash at a cost of $84,500.

– During January, the company will declare and pay $45,000 in cash dividend.

– The company must maintain a minimum cash balance of $30,000. An open line of credit is available at a local bank for any borrowing that may be needed during the quarter. All borrowing is done at the beginning of a month, and all repayments are made at the end of a month. Borrowings and repayments of principals must be in multiples of $1,000. Interest is paid only at the time of payment of principal. The interest rate is 12% per year. (Figure interest on whole month, e.g., 1/12, 2/12.)

Using the data above, complete the following statements and schedules for the first quarter of 2016:

(i) Schedule of expected cash collections:

	January	**February**	**March**	**Quarter**
Cash Sales	$80,000			
Credit Sales	$224,000			
Total Cash Collections	$304,000			

(ii) Inventory purchase budget:

	January	**February**	**March**	**Quarter**
Budgeted cost of goods sold	$240,000	$360,000		
Add: Desired ending inventory	$90,000			
Total needs	$330,000			
Deduct: Beginning inventory	$60,000			
Required purchase	$270,000			

For January sales: $400,000 sales * 60% = $240,000; $360,000* 25% = $90,000.

Contd P/4

IPE 481/ME

Contd ... Q. No. 3(b)

(iii) Schedule of cash disbursements for purchases:

	January	February	March	Quarter
December purchase	$93,000			
January purchase ($270,000)	$135,000	$135,000		
February purchase				
March purchase				
Total cash disbursements	$228,000			

(iv) Schedule of cash disbursements for expenses:

	January	February	March	Quarter
Salaries and wages	$27,000			
Advertising	$70,000			
Freight-out	$20,000			
Other expenses	$12,000			
Total cash disbursements	$129,000			

(v) Cash budget:

	January	February	March	Quarter
Cash balance, beginning	$48,000			
Add cash collections	$304,000			
Total cash available	$352,000			
Less disbursements				
Purchase inventory	$228,000			
Operating expenses	$129,000			
Purchase of equipment	-			
Cash dividends	$45,000			
Total disbursements	$402,000			
Excess (deficiency) of cash	(52,000)			
Financing				

(vi) Prepare an income statement for the quarter ending March 31, 2016 (Ignore income taxes).

(vii) Prepare a balance sheet as of March 31, 2016.

4. (a) Define different components of demand. Define and explain two measurements of errors. **(5+5)**

(b) Forecast including trend for the month of December was 630 units. Trend effect was 25 units. But, the actual demand turned out to be 650 units. Calculate forecast including trend for the month of January. The values of α and δ are 0.80 and 0.30 respectively. **(14)**

(c) A company is planning to replace an existing manual machine with a new CNC machine. The related financial data from the finance and production departments are given below: **($22\frac{2}{3}$)**

Purchase price of the new CNC machine = Tk 50 lacs, Annual maintenance cost = Tk. 1.2 lacs, Increase in profit = Tk. 7 lacs (From year 2 to 8), Tk. 10 lacs (From year 9 to 15). Tk. 8 lacs (From year 16 to 20), Repair cost at 10^{th} year = Tk. 5 lacs, Salvage value = Tk. 15 lacs, Required rate of return = 10%.

Contd P/5

IPE 481/ME

SECTION – B

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

5. (a) Define management. Explain the four management functions. **(14 2/3)**

   (b) Briefly describe the five bases of power. Mention the advantages of delegation. **(8+7)**

   (c) Differentiate mechanistic and organic organizational structure. Describe different types of boundaryless organizations with appropriate examples. **(5+12)**

6. (a) What are the 14 principles of management according to Henri Fayol? Explain. **(16 2/3)**

   (b) Show the decision making process using a neat flow chart. Differentiate between rationality and bounded rationality. **(8+7)**

   (c) Define self-actualization. Write short note on Maslow's need theory. Give a practical example that violates Maslow's need theory of hierarchy. **(15)**

7. (a) Explain the expectancy theory of motivation. **(12 2/3)**

   (b) Write short notes on SWOT analysis and BCG matrix. **(7+10)**

   (c) Mention the relative advantages and disadvantages of different performance appraisal methods. Briefly describe any three selection devices. **(10+7)**

8. (a) Explain the six environmental forces in marketing management. **(16 2/3)**

   (b) Describe the factors which influence consumer behavior. **(15)**

   (c) Mention the factors which determine the width of span for an organizational structure. Explain five competitive forces in industry. **(5+10)**
