L-2/T-2/IPE **Date : 01/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **ME 265** (Thermodynamics and Heat Transfer [redacted])

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

Assume a reasonable value for any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Define Zeroth law of thermodynamics. Explain its importance. **(10)**

(b) Differentiate between reversible and irreversible process. What are the main causes that render irreversibility in a system? **(12)**

(c) Steam enters a turbine operating at steady state with a mass flow rate of 4600 kg/h. The turbine develops a power output of 1000 kW. At the inlet, the pressure is 60 bar, the temperature is 400°C, and the velocity is 10 m/s. At the exit, the pressure is 0.1 bar, the quality is 0.9(90%) and velocity is 50 m/s. Calculate the rate of heat transfer between the turbine and surroundings. **(24⅔)**

2. (a) At the beginning of compression process of an air standard diesel cycle operating with compression ratio of 18, the temperature is 300 K and pressure is 0.1 MPa. The cutoff ratio for the cycle is 2. Determine: **(24⅔)**

(i) the temperature and pressure at end of each process of the cycle.

(ii) the thermal efficiency, and

(iii) the mean effective pressure

(b) Deduce an expression for the thermal efficiency in terms of pressure ratio of a Brayton cycle. **(22)**

3. (a) Give the following statement of second law of thermodynamics: **(10)**

(i) Clausius statement

(ii) Kelvin-Planck statement

(b)What do you understand by boiler mountings and accessories? Give Five examples of each category. **(12)**

(c) What is an economizer? With a net sketch explain its working principle. **(12⅔)**

(d) How can the efficiency of the Rankine cycle be increased? Explain briefly. **(12)**

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4. (a) What are the differences between conventional and Renewable source of energy? Explain the nuclear Fusion reaction. **(16⅔)**

(b) Explain different techniques that can be employed to utilize solar energy. **(14)**

(c) With a neat sketch and T-s diagram, briefly describe combined gas-vapor power cycle. **(10)**

(d) What do you mean by "Perpetual motion machine of First kind (PMM-I)" **(6)**

SECTION – B

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

5. (a) A plate consists of two layers of insulation pressed against each other. Do we need to be concerned about the thermal contact resistance at the interface in a heat transfer analysis or can we just ignore it? Why? **(4)**

(b) The interior of a refrigerator having inside dimensions of 50 cm × 50 cm base area and 120 cm height needs to be maintained at 5°C. The walls of the refrigerator are constructed of two mild steel sheets (each 3 mm thick) and a glass wool insulation layer of 5 mm between them. The convective heat transfer coefficient inside the refrigerator is 10.6 $W/m^2°C$. The refrigerator is placed in a kitchen at 27°C and with a convective transfer coefficient of 25 $W/m^2°C$. Assuming that the refrigerator gains heat only by the side walls, determine the rate of heat gain. **(20)**

Assume, k (mild steel) = 46.4 W/m°C, and k (glass wool) = 0.0464 W/m°C.

(c) An electrical current of 500 A flows through a stainless steel cable having a diameter of 5 mm and an electrical resistance of 6×10^{-4} Ω/m (per meter of the cable length). The cable is in an environment having a temperature of 30°C, and the heat transfer coefficient between the cable and environment is approximately 25 $W/m^2.K$. **(22⅔)**

(i) If a very thin coating of electric insulation is applied to the cable, with a contact resistance of 0.02 $m^2.K/W$, what will be the insulation outer surface temperature?

(ii) What thickness (t) of this insulation (k = 0.5) W/m.K) will yield the lowest value of the maximum insulation temperature?

6. (a) Define Biot number and Nusselt number. Write down their physical significance. **(8)**

(b) Prove that for a body with negligible internal thermal resistance, the transient temperature response for heating or cooling can be obtained from the relation- **(18)**

The symbols have their usual meanings.

$$\frac{T(t)-T\infty}{T_i - T\infty} = e^{-bt} \quad \text{where} \quad b = \frac{hA_s}{\rho V C_p}$$

The symbols have their usual meanings.

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(c) Cylindrical pieces of size 60 mm dia and 60 mm height with density = 7800 kg/m^3, specific heat = 486 J/kgK and thermal conductivity = 43 W/mK are to be heat treated. The pieces initially at 35°C are placed in a furnace at 800°C with convection coefficient at the surface of 85 W/m^{2}K. Determine the time required to heat the pieces to the required temperature of 650°C. **(20⅔)**

If by mistake the pieces were taken out of the furnace after 300 seconds, determine the shortfall in the temperature requirement.

7. (a) What do you understand by the velocity and thermal boundary layers? **(10)**

(b) How does fouling deteriorate the performance of a heat exchanger? **(8)**

(c) Why is Logarithmic Mean Temperature Difference (LMTD) used in the analysis of heat exchanger? **(8)**

(d) Glycerin (C_P = 2400 J/kg°C) at 20°C and 0.3 kg/s is to be heated by ethylene glycol (C_P = 2500 J/kg°C) at 60°C in a thin-walled double-pipe parallel-flow heat exchanger. The temperature difference between the two fluids is 15°C at the outlet of the heat exchanger. If the overall heat transfer coefficient is 240 W/m^2°C and the heat transfer surface area is 3.2 m^2, determine (a) the rate of heat transfer, (b) the outlet temperature of the glycerin, and (c) the mass flow rate of the ethylene glycol. **(20⅔)**

8. (a) Write down the assumptions that are made for an ideal vapor-compression refrigeration system. **(8)**

(b) What are the main differences between window-type and split-type air conditioning system? **(8)**

(c) Define a refrigerant. Write down the chemical formula and type for the following refrigerants – R12, R717, R134, R50, and R290. **(10)**

(d) A refrigeration plant running on an ideal vapor-compression refrigeration cycle operated between the condensing and evaporating pressures of 0.9 MPa and 200 kPa, respectively. For a refrigerant R-134a, the saturated refrigerant vapor coming out of the evaporator has an enthalpy of 244.5 kJ/kg and superheated refrigerant vapor at the end of the compression process has an enthalpy of 275.8 kJ/kg. The condensed refrigerant has an enthalpy of 101.6 kJ/kg. The amount of heat dissipated to the environment by the condenser is 56 kW. **(20⅔)**

Show this cycle on a T-s diagram and determine-(i) The mass flow rate of refrigerant, (ii) Refrigeration effect in kW, and (iii) The COP

How, also determine the isentropic efficiency of the compressor if the superheated refrigerant vapor at the end of the compression process has an enthalpy of 292.5 kJ/kg.

SATURATED STEAM - TEMPERATURE TABLE

		Spec. vol. m^3-kg		Int. Ener. kJ/kg		Enthalpy kJ/kg		Entropy kJ-(kg°K)	
T °C	P bar	Sat. liq. v_f X1000	Sat. vap. v_g	Sat. liq. u_f	Sat. vap. u_g	Sat. liq. h_f	Sat. vap. h_g	Sat. liq. s_f	Sat. vap. s_g
0.01	0.0061	1.0002	206.1	0.01	2376	0.01	2501	0	9.156
4	0.0081	1.0001	157.2	16.79	2381	16.79	2509	0.061	9.051
5	0.0087	1.0001	147.1	21.00	2383	21	2511	0.0762	9.026
6	0.0093	1.0001	137.7	25.21	2384	25.21	2512	0.0912	9.000
8	0.0107	1.0001	120.9	33.61	2387	33.61	2516	0.1212	8.950
10	0.0123	1.0001	106.4	42.01	2389	42.01	2520	0.151	8.901
11	0.0131	1.0007	99.86	46.19	2391	46.19	2522	0.1658	8.876
12	0.0140	1.0007	93.79	50.40	2392	50.4	2523	0.1806	8.852
13	0.0150	1.0007	88.13	54.59	2393	54.59	2525	0.1953	8.828
14	0.0160	1.0007	82.85	58.80	2394	58.8	2527	0.2099	8.805
15	0.0170	1.0007	77.93	62.99	2396	62.99	2529	0.2245	8.781
16	0.0182	1.0013	73.34	67.17	2397	67.17	2531	0.239	8.758
17	0.0194	1.0013	69.05	71.36	2399	71.36	2533	0.2535	8.735
18	0.0206	1.0013	65.04	75.57	2400	75.57	2534	0.2679	8.712
19	0.0220	1.0013	61.30	79.76	2401	79.76	2536	0.2823	8.690
20	0.0234	1.002	57.79	83.94	2403	83.94	2538	0.2966	8.667
21	0.0249	1.002	54.52	88.13	2404	88.13	2540	0.3108	8.645
22	0.0264	1.002	51.45	92.32	2406	92.32	2542	0.3251	8.623
23	0.0281	1.0026	48.58	96.50	2407	96.5	2544	0.3392	8.601
24	0.0298	1.0026	45.89	100.7	2409	100.7	2545	0.3533	8.579
25	0.0317	1.0032	43.36	104.9	2410	104.9	2547	0.3673	8.558
26	0.0336	1.0032	41.00	109.0	2411	109.0	2549	0.3814	8.537
27	0.0357	1.0032	38.78	113.2	2412	113.2	2551	0.3953	8.515
28	0.0378	1.0038	36.69	117.4	2414	117.4	2553	0.4093	8.495
29	0.0401	1.0038	34.73	121.6	2415	121.6	2554	0.4231	8.474
30	0.0425	1.0045	32.90	125.8	2416	125.8	2556	0.4369	8.453
31	0.0450	1.0045	31.17	130.0	2418	130.0	2558	0.4507	8.433
32	0.0476	1.0051	29.54	134.1	2419	134.1	2560	0.4644	8.413
33	0.0503	1.0051	28.01	138.3	2421	138.3	2562	0.478	8.393
34	0.0532	1.0057	26.57	142.5	2422	142.5	2563	0.4917	8.373
35	0.0563	1.0057	25.22	146.7	2423	146.7	2565	0.5053	8.353
36	0.0595	1.0063	23.94	150.8	2425	150.8	2567	0.5188	8.333
38	0.0663	1.007	21.60	159.2	2427	159.2	2571	0.5457	8.295
40	0.0738	1.0076	19.52	167.5	2430	167.5	2574	0.5725	8.257
45	0.0959	1.010	15.26	188.4	2437	188.4	2583	0.6386	8.165
50	0.1235	1.012	12.03	209.3	2443	209.3	2592	0.7037	8.076
55	0.1576	1.015	9.569	230.2	2450	230.2	2601	0.7679	7.991
60	0.1994	1.017	7.671	251.1	2457	251.1	2610	0.8311	7.910
65	0.2503	1.020	6.197	272.0	2463	272.0	2618	0.8934	7.831
70	0.3119	1.023	5.042	293.0	2470	293.0	2627	0.9549	7.755
75	0.3858	1.026	4.131	313.9	2476	313.9	2635	1.016	7.682
80	0.4739	1.029	3.407	334.8	2482	334.9	2644	1.075	7.612
85	0.5783	1.033	2.828	355.8	2488	355.9	2652	1.134	7.544
90	0.7013	1.036	2.361	376.8	2494	376.9	2660	1.193	7.479
95	0.8455	1.039	1.982	397.9	2501	398.0	2668	1.250	7.416
100	1.013	1.044	1.673	418.9	2507	419.0	2676	1.307	7.355
110	1.433	1.052	1.21	461.1	2518	461.3	2691	1.418	7.239
120	1.985	1.060	0.892	503.5	2529	503.7	2706	1.528	7.130
130	2.701	1.069	0.669	546.0	2540	546.3	2720	1.634	7.027
140	3.613	1.080	0.509	588.7	2550	589.1	2734	1.739	6.930
150	4.758	1.091	0.393	631.7	2559	632.2	2746	1.842	6.838
160	6.178	1.102	0.307	674.9	2568	675.5	2758	1.943	6.750
170	7.916	1.114	0.243	718.3	2576	719.2	2769	2.042	6.666
180	10.02	1.127	0.194	762.1	2584	763.2	2778	2.140	6.586
190	12.54	1.141	0.157	806.2	2589	807.6	2786	2.236	6.508
200	15.54	1.156	0.127	850.6	2596	852.4	2793	2.331	6.432
210	19.06	1.172	0.104	895.5	2600	897.8	2798	2.425	6.358
220	23.18	1.190	0.086	940.8	2603	943.6	2802	2.518	6.286
230	27.95	1.209	0.072	986.7	2603	990.1	2804	2.610	6.215
240	33.44	1.229	0.06	1033	2603	1037.3	2804	2.702	6.144
250	39.73	1.251	0.05	1080	2603	1085.3	2802	2.793	6.073
260	46.88	1.275	0.042	1128	2600	1134.4	2797	2.884	6.002
270	54.98	1.302	0.036	1177	2592	1184.5	2790	2.975	5.930
280	64.11	1.332	0.03	1227	2587	1236.0	2780	3.067	5.857
290	74.36	1.365	0.026	1279	2573	1289.0	2766	3.159	5.782
300	85.81	1.403	0.022	1332	2560	1344.0	2749	3.253	5.704
320	112.7	1.499	0.015	1445	2531	1461.5	2700	3.448	5.536
340	145.9	1.638	0.011	1570	2462	1594.1	2622	3.659	5.336
360	186.5	1.893	0.007	1725	2351	1760.5	2481	3.915	5.053
374.14	220.9	3.155	0.003155	2030	2030	2099.3	2099	4.430	4.430

SATURATED STEAM - PRESSURE TABLE

P bar	T °C	Spec. vol. m^3=kg Sat. liq. v_f X1000	Sat. vap. v_g	Int. Ener. kJ/kg Sat. liq. u_f	Sat. vap. u_g	Enthalpy kJ/kg Sat. liq. h_f	Sat. vap. h_g	Entropy kJ=(kg°K) Sat. liq. s_f	Sat. vap. s_g
0.04	28.96	1.004	34.80	121.4	2415	121.4	2554	0.423	8.475
0.06	36.15	1.006	23.75	151.5	2425	151.5	2567	0.521	8.331
0.08	41.5	1.008	18.11	173.8	2432	173.8	2577	0.593	8.229
0.1	45.8	1.010	14.68	191.8	2438	191.8	2585	0.649	8.150
0.2	60.07	1.017	7.649	251.4	2457	251.4	2610	0.832	7.908
0.3	69.11	1.023	5.229	289.2	2468	289.2	2625	0.944	7.769
0.4	75.87	1.026	3.994	317.5	2477	317.6	2637	1.026	7.670
0.5	81.33	1.030	3.240	340.4	2484	340.5	2646	1.091	7.594
0.6	85.94	1.033	2.732	359.8	2490	359.9	2653	1.145	7.532
0.7	89.95	1.036	2.365	376.6	2494	376.7	2660	1.192	7.480
0.8	93.5	1.039	2.087	391.6	2499	391.7	2666	1.233	7.435
0.9	96.71	1.041	1.870	405.1	2503	405.1	2671	1.270	7.395
1	99.62	1.043	1.694	417.3	2506	417.4	2675	1.303	7.359
1.5	111.4	1.053	1.159	466.9	2520	467.1	2694	1.434	7.223
2	120.2	1.061	0.886	504.5	2530	504.7	2707	1.530	7.127
3	133.6	1.073	0.606	561.1	2544	561.5	2725	1.672	6.992
4	143.6	1.084	0.463	604.3	2554	604.8	2739	1.777	6.896
5	151.9	1.093	0.375	639.7	2561	640.2	2749	1.861	6.821
6	158.9	1.101	0.316	669.9	2567	670.6	2757	1.931	6.760
7	165.0	1.108	0.273	696.4	2573	697.2	2764	1.992	6.708
8	170.4	1.115	0.240	720.2	2577	721.1	2769	2.046	6.663
9	175.4	1.121	0.215	741.8	2580	742.8	2774	2.095	6.623
10	179.9	1.127	0.194	761.7	2584	762.8	2778	2.139	6.586
20	212.4	1.177	0.100	906.4	2600	908.8	2800	2.447	6.341
30	233.9	1.217	0.067	1005	2604	1008	2804	2.646	6.187
40	250.4	1.252	0.050	1082	2602	1087	2801	2.796	6.070
50	264.0	1.286	0.039	1148	2597	1154	2794	2.920	5.973
60	275.6	1.319	0.032	1205	2590	1213	2784	3.027	5.889
70	285.9	1.352	0.027	1258	2580	1267	2772	3.121	5.813
80	295.1	1.384	0.024	1306	2570	1317	2758	3.207	5.743
90	303.4	1.418	0.021	1350	2558	1363	2742	3.286	5.677
100	311.1	1.453	0.018	1393	2545	1408	2725	3.360	5.614
110	318.2	1.489	0.016	1434	2530	1450	2706	3.429	5.553
120	324.8	1.527	0.014	1473	2513	1491	2685	3.496	5.492
130	331.0	1.567	0.013	1511	2496	1532	2662	3.561	5.432
140	336.8	1.611	0.012	1549	2477	1571	2638	3.623	5.372
150	342.3	1.658	0.010	1586	2456	1611	2611	3.685	5.310
160	347.4	1.711	0.009	1623	2432	1650	2581	3.746	5.246
170	352.4	1.770	0.008	1660	2405	1690	2547	3.808	5.178
180	357.0	1.839	0.008	1699	2375	1732	2510	3.871	5.105
190	361.5	1.924	0.007	1740	2338	1776	2465	3.938	5.024
200	365.8	2.036	0.006	1786	2295	1826	2411	4.013	4.931
220.9	374.1	3.155	0.003	2030	2029	2099	2099	4.430	4.430

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 0.06 bar				P= 0.35 bar			
T	v	u	h	s	v	u	h	s
80	27.13	2487	2650	8.580	4.625	2484	2646	7.756
100	28.68	2516	2688	8.685	4.895	2513	2684	7.863
120	30.22	2545	2726	8.784	5.163	2542	2723	7.964
160	33.30	2603	2802	8.969	5.696	2601	2801	8.152
200	36.38	2661	2880	9.140	6.228	2660	2878	8.324
240	39.46	2721	2958	9.298	6.757	2720	2957	8.483
280	42.54	2782	3037	9.446	7.286	2781	3036	8.631
320	45.62	2843	3117	9.586	7.814	2843	3116	8.771
360	48.69	2905	3198	9.718	8.341	2905	3197	8.903
400	51.77	2969	3280	9.843	8.872	2969	3279	9.029
450	55.62	3050	3383	9.992	9.532	3049	3383	9.178
500	59.47	3132	3489	10.13	10.19	3132	3489	9.319

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 0.7 bar				P= 1 bar			
T	v	u	h	s	v	u	h	s
100	2.434	2510	2680	7.534	1.695	2506	2676	7.361
120	2.571	2540	2720	7.637	1.793	2537	2717	7.467
160	2.841	2599	2798	7.828	1.984	2598	2796	7.660
200	3.108	2659	2877	8.001	2.172	2658	2875	7.834
240	3.374	2719	2956	8.161	2.359	2719	2954	7.995
280	3.639	2780	3035	8.310	2.545	2780	3034	8.144
320	3.904	2842	3115	8.450	2.730	2842	3115	8.285
360	4.170	2905	3196	8.583	2.917	2904	3196	8.417
400	4.434	2968	3279	8.708	3.102	2968	3278	8.543
450	4.764	3049	3383	8.858	3.334	3049	3382	8.693
500	5.094	3132	3488	8.999	3.565	3132	3488	8.834
550	5.423	3213	3593	9.129	3.796	3216	3596	8.969
600	5.753	3298	3701	9.257	4.027	3302	3705	9.097

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 1.5 bar				P= 3 bar			
T	v	u	h	s	v	u	h	s
120	1.188	2533	2711	7.269	XXX	XXX	XXX	XXX
160	1.317	2595	2793	7.466	0.6506	2587	2782	7.128
200	1.444	2656	2873	7.643	0.7162	2651	2866	7.311
240	1.570	2717	2953	7.805	0.7802	2713	2947	7.477
280	1.694	2779	3033	7.955	0.8438	2775	3029	7.630
320	1.819	2841	3113	8.096	0.9067	2838	3110	7.772
360	1.943	2903	3195	8.229	0.9692	2901	3192	7.906
400	2.067	2967	3277	8.355	1.031	2966	3275	8.033
450	2.221	3048	3382	8.505	1.109	3047	3380	8.183
500	2.376	3131	3488	8.646	1.186	3130	3486	8.325
550	2.530	3216	3595	8.781	1.264	3215	3594	8.460
600	2.684	3302	3704	8.910	1.341	3301	3703	8.589

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 5 bar				P= 7 bar			
T	v	u	h	s	v	u	h	s
160	0.3836	2576	2767	6.865	XXX	XXX	XXX	XXX
200	0.4249	2643	2855	7.059	0.2999	2635	2845	6.886
240	0.4644	2708	2940	7.230	0.3292	2702	2932	7.064
280	0.5034	2771	3023	7.386	0.3574	2767	3017	7.223
320	0.5416	2835	3105	7.531	0.3852	2831	3101	7.370
360	0.5795	2899	3188	7.666	0.4125	2896	3185	7.506
400	0.617	2963	3272	7.793	0.4397	2961	3269	7.635
450	0.6642	3045	3377	7.945	0.4735	3043	3375	7.787
500	0.7109	3128	3484	8.087	0.507	3127	3482	7.930
550	0.7575	3213	3592	8.223	0.5405	3212	3590	8.066
600	0.8041	3300	3702	8.352	0.5738	3298	3700	8.195
650	0.8505	3388	3813	8.476	0.6071	3387	3812	8.320
700	0.8969	3477	3926	8.595	0.6403	3477	3925	8.439

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 10 bar				P= 15 bar			
T	v	u	h	s	v	u	h	s
200	0.2059	2622	2828	6.694	0.1325	2598	2797	6.455
240	0.2275	2693	2920	6.882	0.1482	2677	2899	6.663
280	0.248	2760	3008	7.046	0.1627	2749	2993	6.838
320	0.2678	2826	3094	7.196	0.1765	2817	3082	6.994
360	0.2873	2892	3179	7.335	0.1899	2884	3169	7.136
400	0.3066	2957	3264	7.465	0.203	2951	3256	7.269
450	0.3304	3040	3371	7.618	0.2192	3035	3364	7.424
500	0.3541	3124	3478	7.762	0.2352	3120	3473	7.570
550	0.3776	3210	3587	7.899	0.251	3206	3583	7.707
600	0.4011	3297	3698	8.029	0.2668	3294	3694	7.838
650	0.4245	3385	3810	8.153	0.2825	3383	3806	7.964
700	0.4478	3475	3923	8.273	0.2981	3473	3920	8.084

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 20 bar				P= 30 bar			
T	v	u	h	s	v	u	h	s
240	0.1084	2660	2876	6.495	0.0682	2620	2824	6.226
280	0.12	2736	2976	6.683	0.0771	2710	2941	6.446
320	0.1308	2808	3069	6.845	0.085	2788	3043	6.624
360	0.1411	2877	3159	6.992	0.0923	2862	3139	6.780
400	0.1512	2945	3248	7.127	0.0994	2933	3231	6.921
450	0.1635	3030	3357	7.284	0.1079	3020	3344	7.083
500	0.1757	3116	3468	7.432	0.1162	3108	3456	7.234
550	0.1877	3203	3578	7.570	0.1244	3196	3569	7.375
600	0.1996	3291	3690	7.702	0.1324	3285	3682	7.508
650	0.2114	3380	3803	7.828	0.1404	3375	3796	7.636
700	0.2232	3471	3917	7.949	0.1484	3466	3912	7.757

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 40 bar				P= 60 bar			
T	v	u	h	s	v	u	h	s
280	0.0555	2680	2902	6.257	0.0332	2605	2804	5.925
320	0.062	2767	3015	6.455	0.0387	2720	2952	6.184
360	0.0679	2846	3117	6.621	0.0433	2811	3071	6.378
400	0.0734	2920	3213	6.769	0.0474	2893	3177	6.541
450	0.08	3010	3330	6.936	0.0521	2989	3302	6.719
500	0.0864	3100	3445	7.090	0.0567	3082	3422	6.880
550	0.0927	3189	3560	7.233	0.061	3175	3541	7.029
600	0.0988	3279	3674	7.369	0.0653	3267	3658	7.168
650	0.1049	3370	3790	7.497	0.0694	3360	3776	7.299
700	0.1109	3462	3906	7.620	0.0735	3453	3894	7.423
750	0.1169	3556	4023	7.737	0.0776	3547	4013	7.542

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 80 bar				P= 100 bar			
T	v	u	h	s	v	u	h	s
320	0.0268	2663	2877	5.949	0.0193	2588	2781	5.710
360	0.0309	2773	3020	6.182	0.0233	2729	2962	6.006
400	0.0343	2864	3138	6.363	0.0264	2832	3096	6.212
450	0.0382	2966	3272	6.555	0.0297	2944	3241	6.419
500	0.0417	3065	3398	6.724	0.0328	3046	3374	6.597
550	0.0451	3160	3521	6.878	0.0356	3145	3501	6.756
600	0.0485	3254	3642	7.020	0.0384	3241	3625	6.903
650	0.0517	3349	3762	7.154	0.041	3338	3748	7.040
700	0.0548	3444	3882	7.281	0.0436	3434	3870	7.169
750	0.0579	3540	4003	7.402	0.0461	3532	3993	7.291

SUPERHEATED STEAM

v in m³=kg, u in kJ/kg, h in kJ/kg, s in kJ=(kg°K)

	P= 120 bar				P= 140 bar			
T	v	u	h	s	v	u	h	s
360	0.0181	2678	2896	5.836	0.0142	2618	2816	5.660
400	0.0211	2798	3051	6.075	0.0172	2761	3002	5.945
450	0.0241	2919	3208	6.300	0.0201	2893	3174	6.192
500	0.0268	3027	3348	6.487	0.0225	3007	3322	6.390
550	0.0293	3129	3480	6.653	0.0247	3113	3459	6.562
600	0.0316	3229	3608	6.804	0.0268	3216	3591	6.717
650	0.0339	3327	3734	6.944	0.0288	3316	3720	6.860
700	0.0361	3425	3858	7.075	0.0307	3416	3846	6.994
750	0.0382	3524	3982	7.199	0.0326	3515	3972	7.120
800	0.0403	3611	4095	7.305	0.0344	3604	4085	7.227

L-2/T-2/IPE **Date : 08/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **IPE 207** (Probability and Statistics)

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) Explain ordinal-level data and ratio-level data. **(14)**

(b) Explain relative frequency distribution and cumulative frequency distribution. **(12)**

(c) Two computers A and B are to be marketed. A salesman who is assigned a job of finding customers for them has 60 percent and 40 percent chances respectively of succeeding in case of computers A and B. The computers can be sold independently. Given that he was able to sell at least one computer, what is the probability that the computer A has been sold? **($20\frac{2}{3}$)**

2. (a) In a Gambling game, a woman is paid \$3 if she draws a jack or a queen and \$5 if she draws a king or an ace from an ordinary deck of 52 playing cards. If she draws any other card, she loses. How much should she pay to play if the game is fair? **(12)**

(b) If a machine is set up correctly it produces 90 percent good items, if it is incorrectly setup then it produces 10 percent good items. Chances for a setting to be correct and incorrect are in the ratio of 7 : 3. After a setting is made, the first two items produced are found to be good items. What is the chance that the setting was correct? **(14)**

(c) A manufacturing firm receives shipments of machine parts from two suppliers A and B. Currently, 65 percent of parts are purchased from supplier A and the remaining from supplier B. The past record shows that 2 percent of the parts supplied by A are found defective, whereas 5 percent of the parts supplied by B are found defective. On a particular day the machine breaks down because a defective part is fitted to it. Given the information that the part was bad, using Baye's theorem find the probability that it was supplied by supplier B. **($20\frac{2}{3}$)**

3. (a) Suppose, on an average, one house in 1000, in a certain town, has a fire during the year. If there are 2000 houses, what is the probability that (i) exactly 3 houses, (ii) more than 2 houses will have fire during the year? **(16)**

(b) Explain the Properties of Poisson Process. **(10)**

Contd P/2

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Contd ... Q. No. 3

(c) A government task force suspects that some manufacturing companies are in violation of federal pollution regulations with regard to dumping a certain type of product. Twenty firms are under suspicion but all cannot be inspected. Suppose that 3 of the firms are in violation. **($20\frac{2}{3}$)**

(i) What is the probability that inspection of 5 firms finds no violations?

(ii) What is the probability that the plan above will find two violations?

4. (a) What do you mean by Nonparametric methods. **(6)**

(b) Explain the limitations of Chi-Square test. **(15)**

(c) The bank credit card department of Carollna Bank knows from experience that 5 percent of the card holders have had some high school, 15 percent have completed high school, 25 percent have had some college, and 55 percent have completed college. Of the 500 card holders whose cards, have been called in for failure to pay their charges this month, 50 had some high school, 100 had completed high school, 190 had some college, and 160 had completed college. Can we conclude that the distribution of card holders who do not pay their charges is different from all others? Use the .01 significance level. **($25\frac{2}{3}$)**

SECTION – B

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

5. (a) Describe the reasons for sampling. What do you understand by stratified random sampling? **(12+5=17)**

(b) Briefly explain the central limit theorem. **($7\frac{2}{3}$)**

(c) What are the factors influencing the appropriate sample size? **(6)**

(d) Marty Rowatti recently assumed the position of director of the YMCA of South Jersey. He would like some current data on how long current members of YMCA have been members. To investigate, suppose he selects a random sample of 40 current members. The mean length of membership of those included in the sample is 8.32 years and the standard deviation is 3.07 years. **(16)**

(i) What is the mean of the population?

(ii) Develop a 90% confidence interval for the population mean.

(iii) The previous director, in the summary report she prepared as she retired, indicated the mean length of membership was now "almost 10 years." Does the sample information substantiate this claim? Cite evidence.

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6. (a) Define the following terms- **(5×3=15)**

   (i) Hypothesis testing

   (ii) Level of significance

   (iii) Test statistic

   (iv) Critical value

   (v) P value

   (b) Explain type-I error with an example. **($7\frac{2}{3}$)**

   (c) Ms. Lisa is the budget director for Nexus Inc. She would like to compare the daily travel expenses for the sales staff and the audit staff. She collected the following sample information. **(24)**

Sales ($)	131	135	146	165	136	142	
Audit ($)	130	102	129	143	149	120	139

   At the 0.10 significance level, can she conclude that the mean daily expenses are greater for the sales staff than the audit staff? What is the p-value?

7. (a) Explain the characteristics of the F distribution. **($11\frac{2}{3}$)**

   (c) Recently four airlines have surveyed random passengers regarding their level of satisfaction with a recent flight. The sample scores are given below. The highest possible score was 100. Is there a difference in the mean satisfaction level among the four airlines? Use 0.01 significance level. **(35)**

Eastern	TWA	Northern	Ozark
94	75	70	68
90	68	73	70
85	77	76	72
80	83	78	65
	88	80	74
		68	65
		65	

8. (a) Define coefficient of correlation. Write down the characteristics of coefficient of correlation. **(12)**

   (b) What is the significance of coefficient of determination? **($4\frac{2}{3}$)**

   (c) The National Highway Association is studying the relationship between the number of bidders on a highway project and the winning (lowest) bid for the project. The collected data are as follows. Determine the regression equation and the coefficient of determination. Interpret your answers. **(30)**

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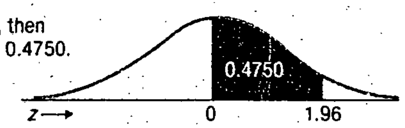
Contd … Q. No. 8(b)

Project	No. of Bidders, X	Winning Bid ($ millions), Y	Project	No. of Bidders, X	Winning Bid ($ millions), Y
1	9	5.1	9	6	10.3
2	9	8.0	10	6	8.0
3	3	9.7	11	4	8.8
4	10	7.8	12	7	9.4
5	5	7.7	13	7	8.6
6	10	5.5	14	7	8.1
7	7	8.3	15	6	7.8
8	11	5.5			

Appendix B: Tables

B.1 Areas under the Normal Curve

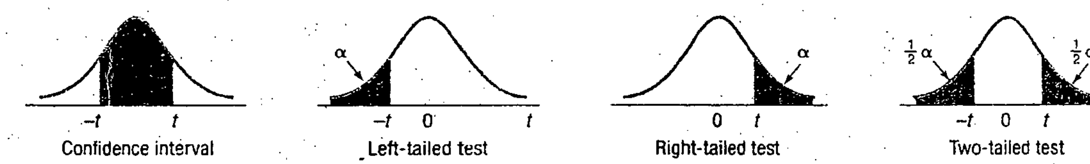
Example:
If $z = 1.96$, then
$P(0 \text{ to } z) = 0.4750$.



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Appendix B

B.2 Student's *t* Distribution



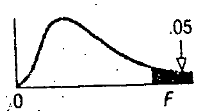
	Confidence Intervals, *c*					
	80%	90%	95%	98%	99%	99.9%
	Level of Significance for One-Tailed Test, α					
df	0.10	0.05	0.025	0.01	0.005	0.0005
	Level of Significance for Two-Tailed Test, α					
	0.20	0.10	0.05	0.02	0.01	0.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.924
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
31	1.309	1.696	2.040	2.453	2.744	3.633
32	1.309	1.694	2.037	2.449	2.738	3.622
33	1.308	1.692	2.035	2.445	2.733	3.611
34	1.307	1.691	2.032	2.441	2.728	3.601
35	1.306	1.690	2.030	2.438	2.724	3.591

	Confidence Intervals, *c*					
	80%	90%	95%	98%	99%	99.9%
	Level of Significance for One-Tailed Test, α					
df	0.10	0.05	0.025	0.01	0.005	0.0005
	Level of Significance for Two-Tailed Test, α					
	0.20	0.10	0.05	0.02	0.01	0.001
36	1.306	1.688	2.028	2.434	2.719	3.582
37	1.305	1.687	2.026	2.431	2.715	3.574
38	1.304	1.686	2.024	2.429	2.712	3.566
39	1.304	1.685	2.023	2.426	2.708	3.558
40	1.303	1.684	2.021	2.423	2.704	3.551
41	1.303	1.683	2.020	2.421	2.701	3.544
42	1.302	1.682	2.018	2.418	2.698	3.538
43	1.302	1.681	2.017	2.416	2.695	3.532
44	1.301	1.680	2.015	2.414	2.692	3.526
45	1.301	1.679	2.014	2.412	2.690	3.520
46	1.300	1.679	2.013	2.410	2.687	3.515
47	1.300	1.678	2.012	2.408	2.685	3.510
48	1.299	1.677	2.011	2.407	2.682	3.505
49	1.299	1.677	2.010	2.405	2.680	3.500
50	1.299	1.676	2.009	2.403	2.678	3.496
51	1.298	1.675	2.008	2.402	2.676	3.492
52	1.298	1.675	2.007	2.400	2.674	3.488
53	1.298	1.674	2.006	2.399	2.672	3.484
54	1.297	1.674	2.005	2.397	2.670	3.480
55	1.297	1.673	2.004	2.396	2.668	3.476
56	1.297	1.673	2.003	2.395	2.667	3.473
57	1.297	1.672	2.002	2.394	2.665	3.470
58	1.296	1.672	2.002	2.392	2.663	3.466
59	1.296	1.671	2.001	2.391	2.662	3.463
60	1.296	1.671	2.000	2.390	2.660	3.460
61	1.296	1.670	2.000	2.389	2.659	3.457
62	1.295	1.670	1.999	2.388	2.657	3.454
63	1.295	1.669	1.998	2.387	2.656	3.452
64	1.295	1.669	1.998	2.386	2.655	3.449
65	1.295	1.669	1.997	2.385	2.654	3.447
66	1.295	1.668	1.997	2.384	2.652	3.444
67	1.294	1.668	1.996	2.383	2.651	3.442
68	1.294	1.668	1.995	2.382	2.650	3.439
69	1.294	1.667	1.995	2.382	2.649	3.437
70	1.294	1.667	1.994	2.381	2.648	3.435

(continued)

Appendix B

B.4 Critical Values of the F Distribution at a 5 Percent Level of Significance



Degrees of Freedom for the Denominator	Degrees of Freedom for the Numerator															
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251
2	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5	19.5
3	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39

Appendix B

B.4 Critical Values of the F Distribution at a 1 Percent Level of Significance (*concluded*)

Degrees of Freedom for the Denominator	Degrees of Freedom for the Numerator															
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40
1	4052	5000	5403	5625	5764	5859	5928	5981	6022	6056	6106	6157	6209	6235	6261	6287
2	98.5	99.0	99.2	99.2	99.3	99.3	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.5	99.5	99.5
3	34.1	30.8	29.5	28.7	28.2	27.9	27.7	27.5	27.3	27.2	27.1	26.9	26.7	26.6	26.5	26.4
4	21.2	18.0	16.7	16.0	15.5	15.2	15.0	14.8	14.7	14.5	14.4	14.2	14.0	13.9	13.8	13.7
5	16.3	13.3	12.1	11.4	11.0	10.7	10.5	10.3	10.2	10.1	9.89	9.72	9.55	9.47	9.38	9.29
6	13.7	10.9	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.72	7.56	7.40	7.31	7.23	7.14
7	12.2	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31	6.16	6.07	5.99	5.91
8	11.3	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52	5.36	5.28	5.20	5.12
9	10.6	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96	4.81	4.73	4.65	4.57
10	10.0	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56	4.41	4.33	4.25	4.17
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.40	4.25	4.10	4.02	3.94	3.86
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01	3.86	3.78	3.70	3.62
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.96	3.82	3.66	3.59	3.51	3.43
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.80	3.66	3.51	3.43	3.35	3.27
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.67	3.52	3.37	3.29	3.21	3.13
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.55	3.41	3.26	3.18	3.10	3.02
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.46	3.31	3.16	3.08	3.00	2.92
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23	3.08	3.00	2.92	2.84
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.92	2.84	2.76
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.86	2.78	2.69
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.80	2.72	2.64
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.75	2.67	2.58
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.70	2.62	2.54
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.66	2.58	2.49
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.62	2.54	2.45
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.47	2.39	2.30
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.66	2.52	2.37	2.29	2.20	2.11
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.12	2.03	1.94
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.03	1.95	1.86	1.76
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04	1.88	1.79	1.70	1.59

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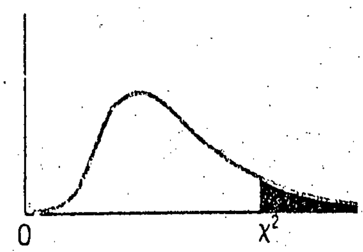
Appendix B

B.3 Critical Values of Chi-Square

This table contains the values of χ^2 that correspond to a specific right-tail area and specific number of degrees of freedom.



Example: With 17 *df* and a .02 area in the upper tail, $\chi^2 = 30.995$

Degrees of Freedom, *df*	Right-Tail Area			
	0.10	0.05	0.02	0.01
1	2.706	3.841	5.412	6.635
2	4.605	5.991	7.824	9.210
3	6.251	7.815	9.837	11.345
4	7.779	9.488	11.668	13.277
5	9.236	11.070	13.388	15.086
6	10.645	12.592	15.033	16.812
7	12.017	14.067	16.622	18.475
8	13.362	15.507	18.168	20.090
9	14.684	16.919	19.679	21.666
10	15.987	18.307	21.161	23.209
11	17.275	19.675	22.618	24.725
12	18.549	21.026	24.054	26.217
13	19.812	22.362	25.472	27.688
14	21.064	23.685	26.873	29.141
15	22.307	24.996	28.259	30.578
16	23.542	26.296	29.633	32.000

L-2/T-2/IPE **Date : 02/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **ME 243** (Mechanics of Solids)

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. Assume any reasonable value for missing data.

1. (a) A uniform bar AB of weight w = 25N is supported by two springs as shown in fig. 1(a). The spring on the left has stiffness k_1 = 300 N/m and natural length L_1 = 250 mm. The corresponding quantities for the right spring are k_2 = 400 N/m and L_2 = 200 mm. The distance between the springs is L = 350 mm, and the spring on the right is suspended from a support that is distance h = 80 mm below the point of support of left spring. At what distance x from the left-hand spring should a load P = 18 N be placed in order to bring the bar to a horizontal position? **(20)**

   (b) A nylon bar having diameter d_1 = 8.89 cm is placed inside a steel tube having inner diameter d_2 = 8.92 cm as shown in fig. 1(b). The nylon bar is then compressed by an axial force P. At what value of the force P, will the space between the nylon bar and the steel tube be closed? **(15)**

   (For nylon, assume E = 2.8 GPa and ν = 0.4).

2. (a) A shaft composed of segments AC, CD, and DB is fastened to rigid supports and loaded as shown in fig. 2(a). For bronze, G = 35 GPa, aluminum, G = 28 GPa, and for steel, G = 83 GPa, Determine the maximum shearing stress developed in each segment. **(20)**

   (b) Two-shafts 12.7 cm in diameter are to be joined by a bolted coupling. If the maximum allowable shearing unit stress in the shafts is 6.895×10^4 kPa the diameter of the bolt circle is 25.4 cm and the allowable shearing unit stress in the bolt 62.1×10^3 kPa, find the number of 2.22 cm bolts necessary for the connection. **(15)**

3. (a) An aluminum column of length L and rectangular cross-section has a fixed end at B and supports a centric load at A as shown in fig. 3(a). Two smooth and rounded fixed plates restrain end A from moving in one of the vertical planes of symmetry but allow it to move in the other plane. Determine- **(20)**

   (i) the ratio a/b of the two sides of the cross-section corresponding to the most efficient design against buckling.

   (ii) Design the most efficient cross-section for the column knowing that L = 59.8 cm, E = 70 GPa P = 22.24 kN and factor of safety FS = 2.5 are required.

Contd P/2

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Contd ... Q. No. 3

(b) An axial load P is applied to the 32-mm-square aluminum bar BC as shown in fig. 3(b). When P = 24 kN, the horizontal deflection at C is 4 mm. Use E = 70 GPa and determine (i) the eccentricity of the load, (ii) the maximum stress in the bar. **(15)**

4. (a) The solid rod (as shown in fig. 4) has a radius of 0.75 cm. If it is subjected to the loading shown, determine the stress at point A. Also draw the stress distribution at A. **(25)**

(b) A timber beam is reinforced with steel plates rigidly attached at the top and bottom as shown fig. 4(b). Determine the amount of moment for the steel plate reinforcement if n = 15 and allowable stresses in wood and steel are 8 MPa and 120 MPa respectively. **(10)**

SECTION – B

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

5. (a) A simply supported beam is subjected to a triangular distribution of load over, half of its length and a couple as shown in Figure 5(a). Draw the shear force and bending moment diagrams. **(18)**

(b) A simply supported beam of 50 mm × 100 mm is subjected to a couple of 6 kNm and a concentrated load of 5 kN as shown in Figure 5(b). Find the maximum flexure stress and the maximum shearing stress developed in the beam. **(17)**

6. (a) Using double integration method find an expression of maximum deflection of a cantilever beam of length L subjected to a uniformly distributed load of w over half of its length form its free end, as shown in Figure 6(a). **(18)**

(b) Using area moment method find an expression of maximum deflection of a cantilever beam of length L subjected to three equal concentrated loads P as shown in Figure 6(b). **(17)**

7. (a) A thin-walled cylindrical pressure vessel is fabricated from the steel plate of thickness 10 mm. If the length and internal diameter of the pressure vessel are respectively 2.5 m and 500 mm, determine the maximum internal pressure that can be applied. Tangential stress is limited to 80 MPa and longitudinal stress is limited to 100 MPa. **(15)**

(b) Derive expressions of maximum radial and maximum tangential stresses for a thick-walled cylinder subjected to external pressure only. **(20)**

8. (a) A stepped circular bar made of steel is placed between two rigid walls in close fit condition at temperature 20°C as shown in Figure 8(a). Determine the stresses in the portions AB and BC, when the temperature increases to 90°C. Consider d = 20 mm, E_{st} = 200 GPa and $\alpha = 12 \times 10^{-6}$ m/m°C. **(17)**

(b) A C-frame is subjected to a load P = 2.5 kN, as shown in Figure 8(b). Determine the normal stresses at the inner and outer fibers along the section a – a. **(18)**

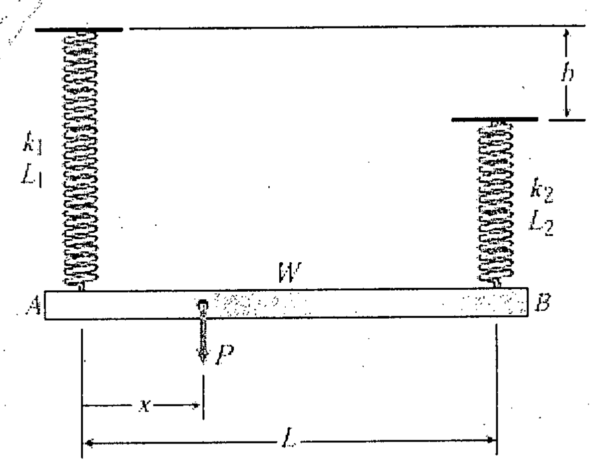

Figure for Que. No. 1(a)

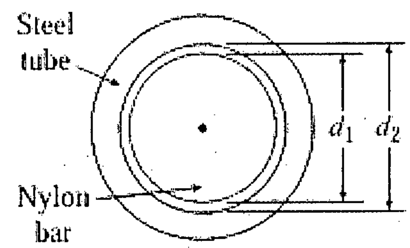

Figure for Que. No. 1(b)

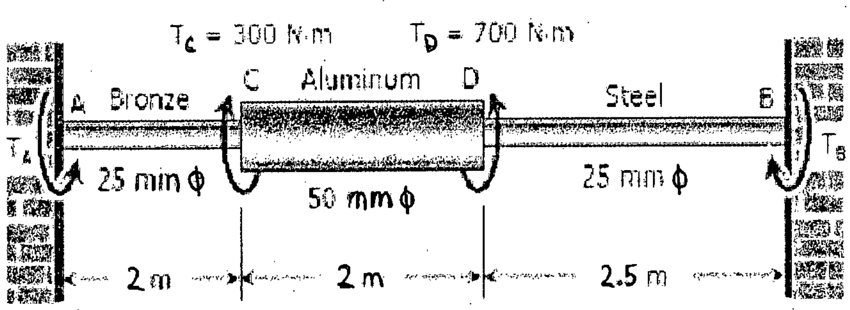

Figure for Que. No. 2(a)

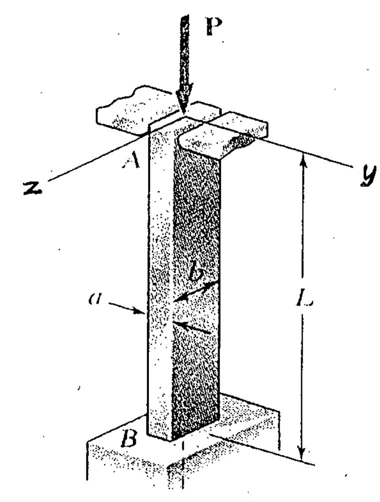

Figure for Que. No. 3(a)

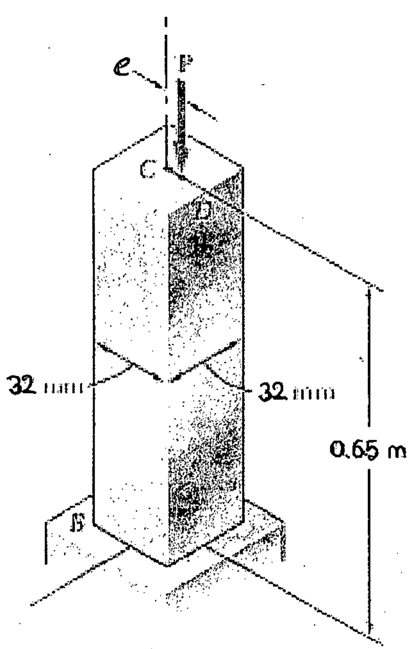

Figure for Que. No. 3(b)

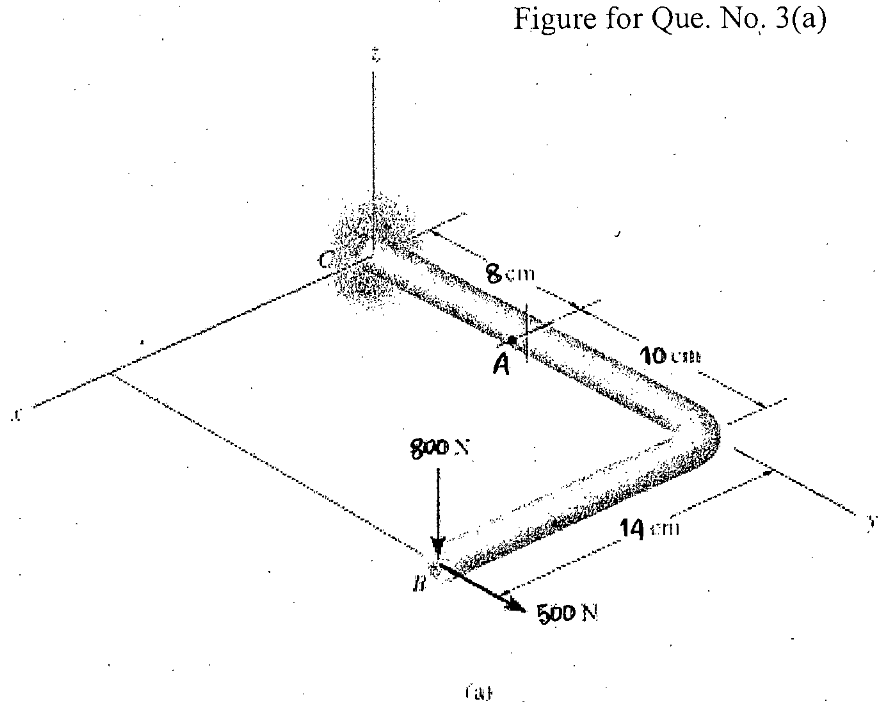

Figure for Que. No. 4(a)

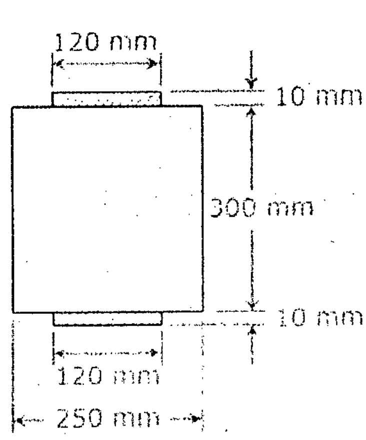

Figure for Que. No. 4(b)

ME-243 (IPE)

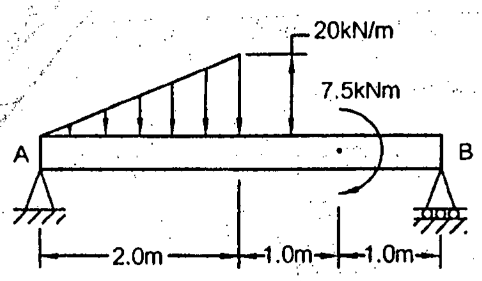

Figure 5(a)

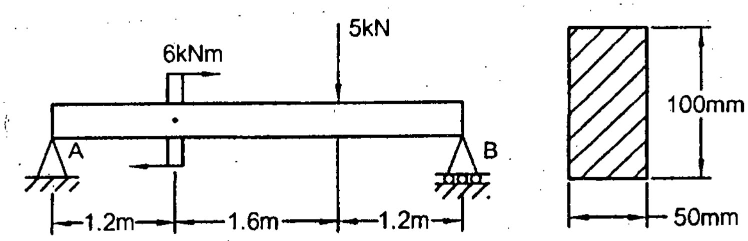

Figure 5(b)

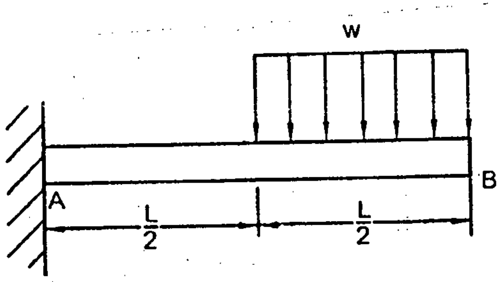

Figure 6(a)

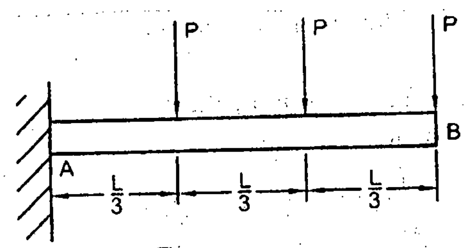

Figure 6(b)

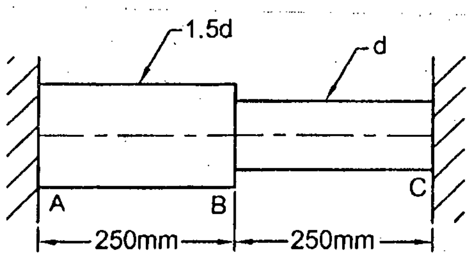

Figure 8(a)

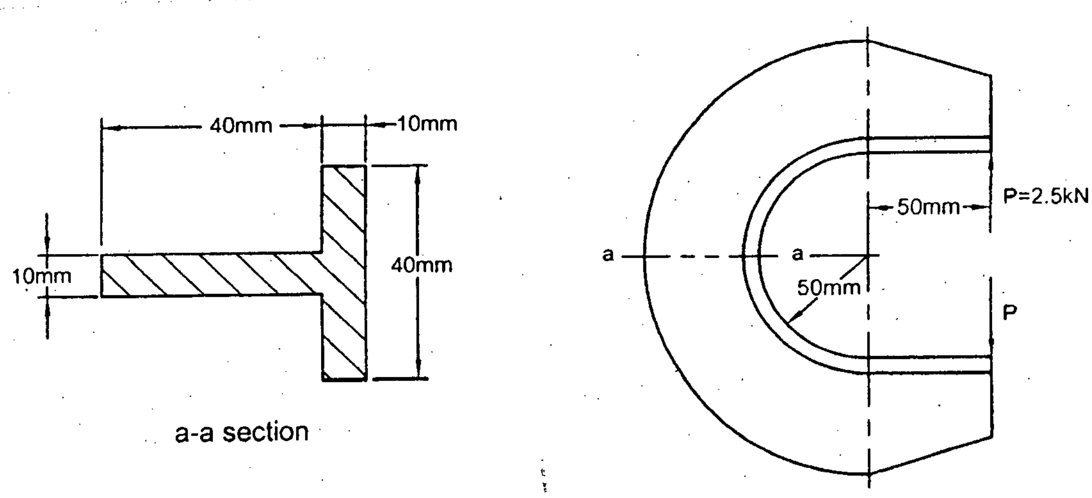

Figure 8(b)

L-2/T-2/IPE **Date : 06/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **IPE 205** (Manufacturing Process-I)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Write short notes on the following: **(12)**

   (i) Cope and drag pattern

   (ii) Follow board pattern

   (iii) Dry and molding

   (b) With the help of suitable diagrams, describe the following: **(14)**

   (i) Squeeze casting

   (ii) Gravity die casting

   (c) What are the functions of a chill? Discuss the considerations that must be taken into account for designing risers in molds. **(9)**

2. (a) Describe the following cold working of metals using sketches: **(15)**

   (i) Metal piercing

   (ii) Metal hobbing

   (iii) Isothermal forging

   (b) Describe the common types of forging hammers. With the help of simple sketches, describe different types of mechanical presses. **(12)**

   (c) With the help of suitable sketches, mention the different types of tube drawing operation. List some of the common defects of extrusion and discuss the possible causes of each defect. **(8)**

3. (a) With the help of diagrams, describe the following sheet metal forming operations: **(12)**

   (i) Flanging

   (ii) Press Break Forming

   (iii) Building

   (b) With the help of diagrams, describe the following sheet metal forming operations: **(14)**

   (i) Hydroform process

   (ii) Explosive forming process (Standoff technique)

   (c) Explain deep drawing and Ironing, using sketches. What are the stages involved in manufacturing beverage can? Explain using sketches. **(9)**

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4. (a) Compare the major differences between glass, ceramics and metals. Explain why ceramics are weaker in tension than in compression. **(10)**

(b) With the help of diagrams, discuss the following shaping methods for glass: **(15)**

(i) Pressing (ii) Blow forming (iii) Rolling

(c) Explain briefly the general characteristics of various types of composite materials. Compare the advantages and disadvantages of metal-matrix composites and ceramic matrix composites. **(10)**

SECTION – B

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

5. (a) With neat sketches, describe briefly the investment casting. Discuss the advantages and limitations of investment casting in comparison with sand mold casting. **(12)**

(b) What is the difference between open-die and close-die forging? Why is open-die forging not a practical technique for large scale production of identical products? Explain. **(11)**

(c) List some operations that can be classified as bending. With the help of diagram, describe a compound, a progressive and a transfer die. **(12)**

6. (a) Briefly describe different types of welding joints. What is the purpose of using flux and filler rod in welding operation? **(15)**

(b) What are the similarities and differences between TIG welding and MIG welding process? **(12)**

(c) Write down the necessity of electrode force in resistance welding. What happens if electrode force is not appropriate? **(8)**

7. (a) Describe the reactions that take places in oxyacetylene welding. Explain different types of flames used in gas welding. **(12)**

(b) How different types of seams can be produced in resistance welding? **(8)**

(c) Explain the working principle of Honing and lapping processes. **(15)**

8. (a) Discuss the working principle of a thermo-chemical welding. **(8)**

(b) Differentiate soldering and brazing. Briefly describe soldering joint design principles. **(12)**

(c) Describe the main causes and remedies of Cracking, Inadequate Joint Penetration, Porosity, Inclusion and Incomplete Fusion in welding joint. **(15)**

L-2/T-2/IPE **Date : 10/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **IPE 209** (Engineering Economy)

Full Marks : 140 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) Discuss the elements that should be considered in deciding on an interest rate to be used in the evaluation of public projects. **(5)**

(b) List the factors that would have a significant effect on a city's decision to develop a mass transportation system. Indicate which factors could be quantified and which would be considered non-quantifiable. **(8)**

(c) A township has \$5,000,000 available to spend on flood-control projects. Project A is expected to generate flood prevention benefits of \$460,000 per year for an investment of \$3,000,000 and annual maintenance expenses of \$57,000. Project B, costing \$4,000,000 with maintenance expenses of \$81,500 per year, is expressed to produce annual savings of \$613,000 due to reduced flooding. Both projects are expected to last 40 years. For an interest rate of 10%, compute the benefit-cost ratio for each project and then calculate the incremental benefit-cost ratio. Which approach does provide the correct result? **($10\frac{1}{3}$)**

2. (a) What s MACRS? Discuss its advantages. **(5)**

(b) Exactly 10 years ago, Boyditch Professional Associates purchased \$ 100,000 in depreciable assets with an estimated salvage of \$10,000. For tax depreciation the SL method with n = 10 years was used, but for book depreciation, Boyditch applied the Double Declining Balance (DBB) method with n = 7 years and neglected the salvage estimate. The company sold the assets today for \$12,500. (i) Compare this amount with the book values using the SL and DDB methods. (ii) If the salvage of \$12,500 had been estimated exactly 10 years ago, determine the depreciation for each method in year 10. **($10\frac{1}{3}$)**

(c) There are 3 different life (recovery period) values associated with a depreciable asset. Identify each by name and explain how it is correctly used. **(8)**

3. (a) What are the principles of engineering economy? Briefly discuss with appropriate examples. **(10)**

(b) Do you agree or disagree with the following statement? "Most business would not obtain maximum profits by maximizing revenue". Justify your answer. **(8)**

(c) Define *standard cost* and list some of its typical uses. **($5\frac{1}{3}$)**

Contd P/2

4. (a) What is cost-driven design optimization? Outline a general approach for optimizing a design with respect to cost. **(7)**

(b) The cost of operating a large ship (C_0) varies as the square of its velocity (v); specifically, $C_0 = knv^2$, where n is the trip length in miles and k is a constant of proportionality. It is known that at 12 miles/hour, the average cost of operation is \$100 per mile. The owner of the ship wants to minimize the cost of operation, but it mist be balanced against the cost of the perishable cargo (C_c), which the customer has set at \$1,500 per hour. (i) At what velocity should the trip be planned to minimize the total cost (C_T), which is the sum of the cost of operating the ship and the cost of perishable cargo? (ii) How do you know that your answer for the problem in Part (i) minimizes that total cost? **(8⅓)**

(c) A company produces and sells a consumer product and is able to control the demand for the product by varying the selling price. The approximate relationship between price and demand is

$$p = \$38 + \frac{2{,}700}{D} - \frac{5{,}000}{D^2}, \text{ for } D > 1,$$

where p is the price per unit in dollars and D is the demand per month. The company is seeking to maximize its profit. The fixed cost is \$1,000 per month and the variable cost (c_v) is \$40 per unit. (i) What is the number of units that should be produced and sold each month to maximize profit? (ii) Show that your answer to Part (i) maximizes profit. **(8)**

SECTION – B

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

5. (a) Describe the differences between **(10)**
   (i) Equity capital and debt capital
   (ii) Simple interest and compound interest
   (iii) Nominal interest rate and effective interest rate

(b) Find the value of the unknown quantity in the cash flow diagram below to establish equivalence of cash inflows and outflows. Let i = 12% per year. **(13⅓)**

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6. (a) If nominal interest rate is 18%, what is the effective annual interest rate if compounding takes place monthly. If compounding take place continuously? **(10)**

   (b) You purchased a building five years ago for \$100,000. Its annual maintenance expense has been \$5,000 per year. At the end of third years, you spent \$9,000 on roof repairs. At the end of the fifth years (now), you sell the building for \$120,000. During the period of ownership, you rented the building for \$10,000 per year paid at the beginning of each year. Use the AW method to evaluate this investment when your MARR is 12% per year. **(13 $\frac{1}{3}$)**

7. (a) What is Minimum Attractive Rate of Return (MARR)? What are the major considerations in determining MARR. **(7)**

   (b) You are presented with the summary of projected costs and annual receipts for new product line. Calculate the IRR for this investment opportunity. The company's MARR is 10% per year. **(17 $\frac{1}{3}$)**

End of year	Net Cash Flow, \$
0	– 450,000
1	– 42,500
2	+ 92,800
3	+ 386,000
4	+ 614,600
5	202,200

   Rework the problem with ERR method, when C = MARR per year.

8. (a) You bought a \$1,000 bond at par (face value) that paid nominal interest at the rate of 10%, payable semiannually, and held it for 10 years. You then sold it at a price that resulted in a yield of 8% nominal interest compounded semiannually on your capital. What was the selling price? **(13)**

   (b) How much should be deposited each year for 12 years if you wish to withdraw \$309 each year for five years, beginning at the end of the 15th year? Let i = 12% per year. **(10 $\frac{1}{3}$)**
