L-2/T-2/IPE **Date : 16/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **ME 265** (Thermal Engineering and Heat Transfer)

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) Discuss critical thickness of insulation. Derive the expression for critical radius of insulation. **(15)**

(b) A 200°C, 5.0 cm diameter pipe is exposed to room air at 20°C with h = 3.0 $W/m^2.K$. Calculate the heat loss from the pipe with and without an asbestos insulation [k = 0.17 W/m.K] of 2.0 cm over the pipe. Explain your results. **(20)**

(c) A composite wall is formed of a 2.5 cm copper plate [k = 385 W/m.K], a 3.2 mm layer of asbestos [k = 0.2 W/m.K] and a 5.0 cm layer of fiber glass [k = 0.06 W/m.K]. The wall is subjected to an overall temperature difference of 560°C. Calculate the heat flow per unit area through the composite structure. **($11\frac{2}{3}$)**

2. (a) What is fin? Write down the governing equation and boundary conditions for fins. **(10)**

(b) A plane wall 7.5 cm thick generates heat internally at the rate of 0.35 MW/m^3. One side of the wall is insulated and the other side is exposed to an environment of 93°C. The convection heat transfer coefficient between the wall and the environment is 570 $W/m^2.K$. The thermal conductivity of the wall is 21 W/m.K. Calculate the maximum temperature in the wall. **($20\frac{2}{3}$)**

(c) A long aluminum cylinder 5.0 cm in diameter and initially at 200°C is suddenly exposed to a convection environment at 70°C and h = 525 $W/m^2.K$. Calculate the temperature at a radius of 1.25 cm and the heat lost per unit length 1 min after the cylinder is exposed to the environment. [k = 215 W/m.K, ρ = 2700 kg/m^3, c = 0.9 kJ/kg.K]. **(16)**

3. (a) A 1.0 kW heater is constructed of a glass plate with an electrically conducting film which produces a constant heat flux. The plate is 60 by 60 cm and placed in an airstream at 27°C, 1 atm with u_α = 5 m/s. Determine (i) the average temperature difference, (ii) the temperature difference at the trailing edge, and (iii) the average heat transfer coefficient. [$Nu_x = 0.453\ Re_x^{1/2}\ Pr^{1/3}$]. **(23)**

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ME 265/IPE

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(b) The vertical 0.8-m-high, 2-m-wide double-pane window shown in Fig. 3(b) consists of two sheets of glass separated by a 2-cm air gap at atmospheric pressure. If the glass surface temperatures across the air gap are measured to be 12°C and 2°C, determine the rate of heat transfer through the window. **($23\frac{2}{3}$)**

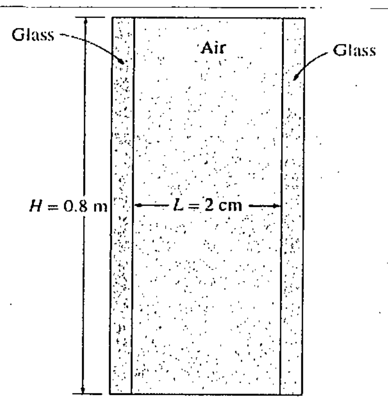

Fig. 3(b)

4. (a) Discuss the use of LMTD method and effectiveness-NTU method for heat exchangers. **(10)**

(b) A cross-flow finned tube (both fluids unmixed) heat exchanger uses hot water to heat an appropriate quantity of air from 15°C to 25°C. The water enters the heat exchanger at 70°C and leaves at 40°C, and the total heat transfer rate is to be 29 kW. The overall heat transfer coefficient is 45 W/m^2K. Calculate the area of the heat exchanger. **(20)**

(c) A glass plate 30 cm square is used to view radiation from a furnace. The transmissivity of the glass is 0.5 in the range from 0.2 to 3.5 μm. The emissivity may be assumed to be 0.3 up to 3.5 μm and 0.9 above that. The transmissivity of the glass is zero, except in the range from 0.2 to 3.5 μm. Assuming that the furnace is a blackbody at 1500°C, calculate the energy absorbed in the glass and the energy transmitted. **($16\frac{2}{3}$)**

SECTION – B

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

5. (a) Distinguish between the higher heating value and the lower heating value of a fuel. **(6)**

(b) How does a concentrated solar collector harness solar energy? **(10)**

(c) Specify where the following components are located on a modern boiler. Also write down their functions in boiler operation. **(12)**

(i) Blow-off cock
(ii) Fusible plug
(iii) Air pre-heater

(d) With the help of a suitable schematic diagram, briefly explain the working principle and construction of Babcock and Wilcox boiler. **($18\frac{2}{3}$)**

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6. (a) Why is Rankine cycle chosen as the practicable ideal cycle instead of Carnot cycle? **(10)**

(b) With the help of appropriate T-S diagrams, explain the effects of (i) superheat and (ii) condenser pressure on the efficiency of a simple Rankine cycle. **(15)**

(c) A simple ideal Ranikne cycle with water as the working fluid operates between the pressure limits of 15 MPa in the boiler and 100 kPa in the condenser. Saturated steam enters the turbine. Determine the work produced by the turbine, the heat transferred in the boiler, and thermal efficiency of the cycle. **($21\frac{2}{3}$)**

7. (a) What are the differences between a heat engine, heat pump and a refrigerator? **(8)**

(b) An inventor claims to have developed an engine that takes in 105 MJ at a temperature of 400 K, rejects 42 MJ at a temperature of 200 K, and delivers 15 kWh of mechanical work. Is it a reasonable claim? Why? **($14\frac{2}{3}$)**

(c) Write down the industrial name and type of the following refrigerants: **(9)**

Water, Nitrogen, CH_2ClF, CH_3CCl_2F, CH_3CH_3, CF_3CF_3

(d) What are the major functions of an air-conditioning system? Write down the differences between window-type and spilt-type air conditioning systems. **(15)**

8. (a) Mention few advantages and disadvantages of gas turbines. **(6)**

(b) In a gas turbine plant working on the air-standard Brayton cycle, the air at the inlet is at 27°C, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is 800°C. The turbine and compressor efficiencies are each 80%. Find, per kg of air, (i) the compressor work, (ii) the turbine work, and (iii) the cycle efficiency. **($20\frac{2}{3}$)**

(c) An engine is operating on the air-standard Otto cycle with the following data: Maximum temperature 1400 K, exhaust temperature 700 K. State of air at the beginning of compression 0.1 MPa, 300 K. Determine the compression ratio and efficiency of the cycle. **(20)**

…10 Axis temperature for an infinite cylinder of radius r_0, from Ref. 2.

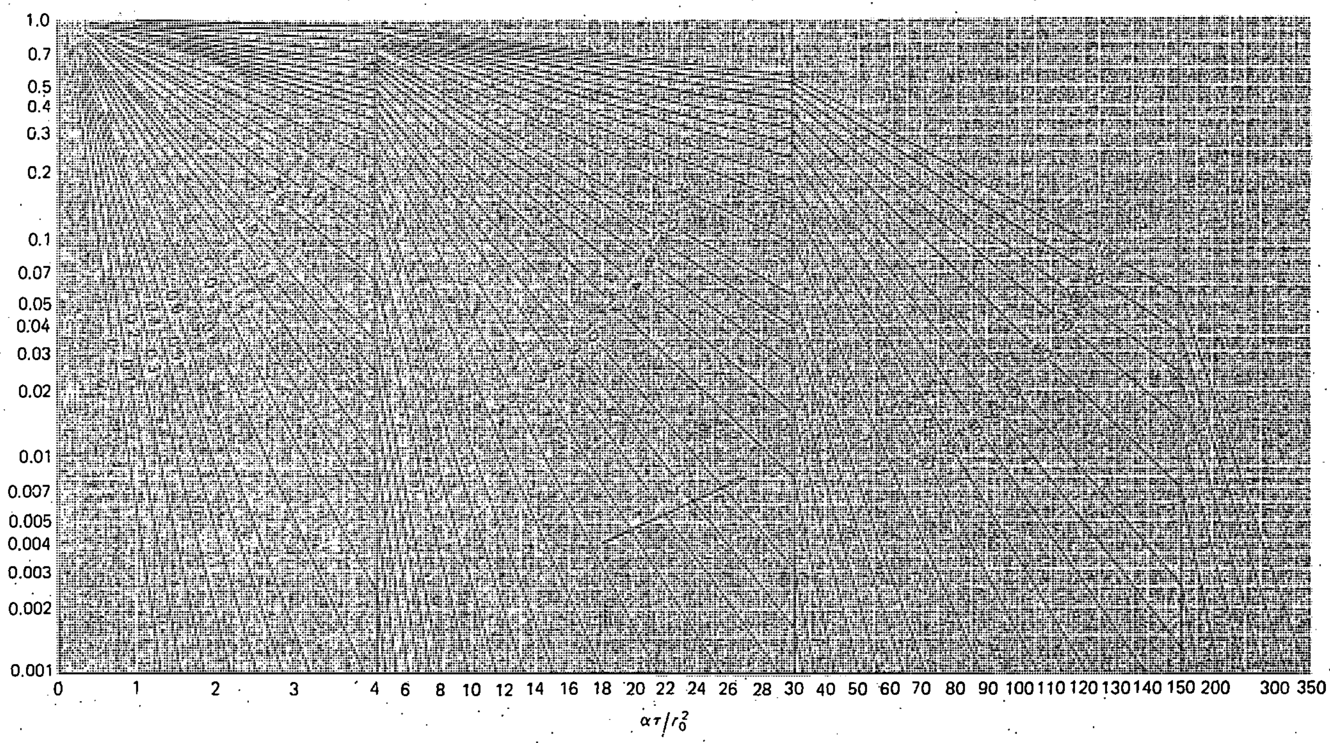


Fig. Temperature as a function of axis temperature in an infinite cylinder of radius r_0, from Ref. 2.

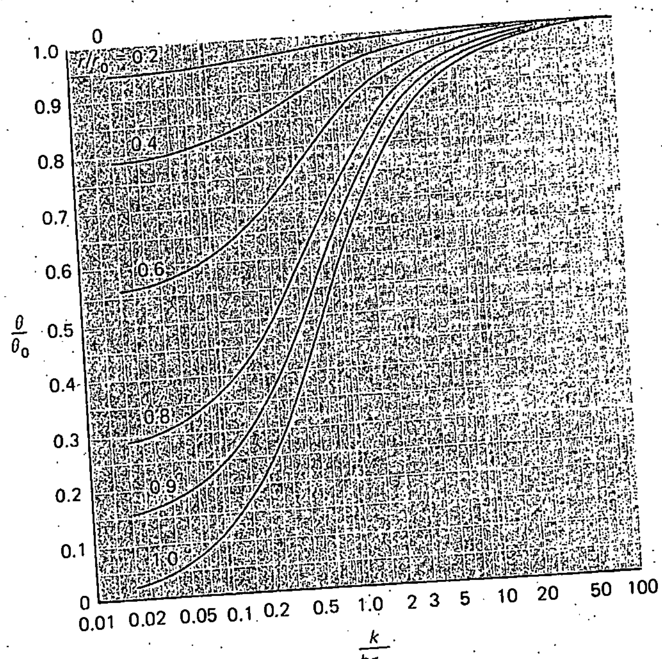
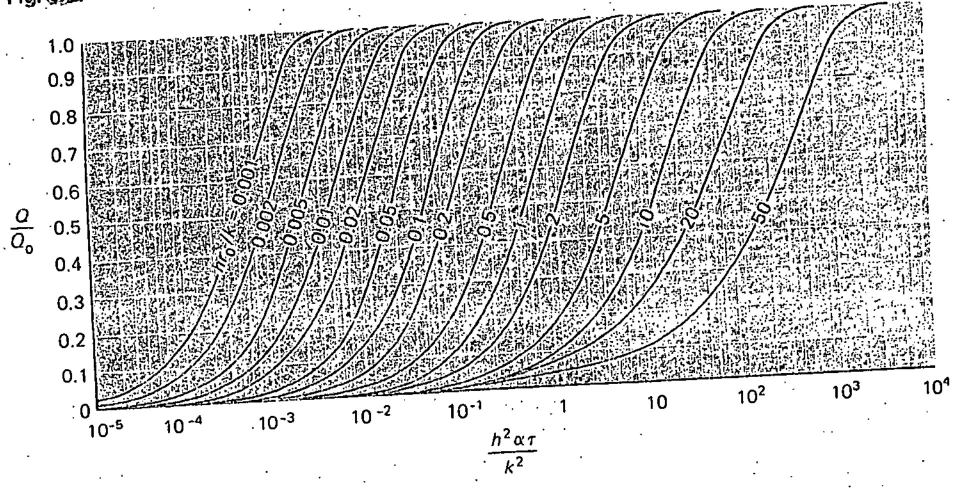


Fig. Dimensionless heat loss Q/Q_0 of an infinite cylinder or radius r_0 with time, from Ref. 6.



ME 265

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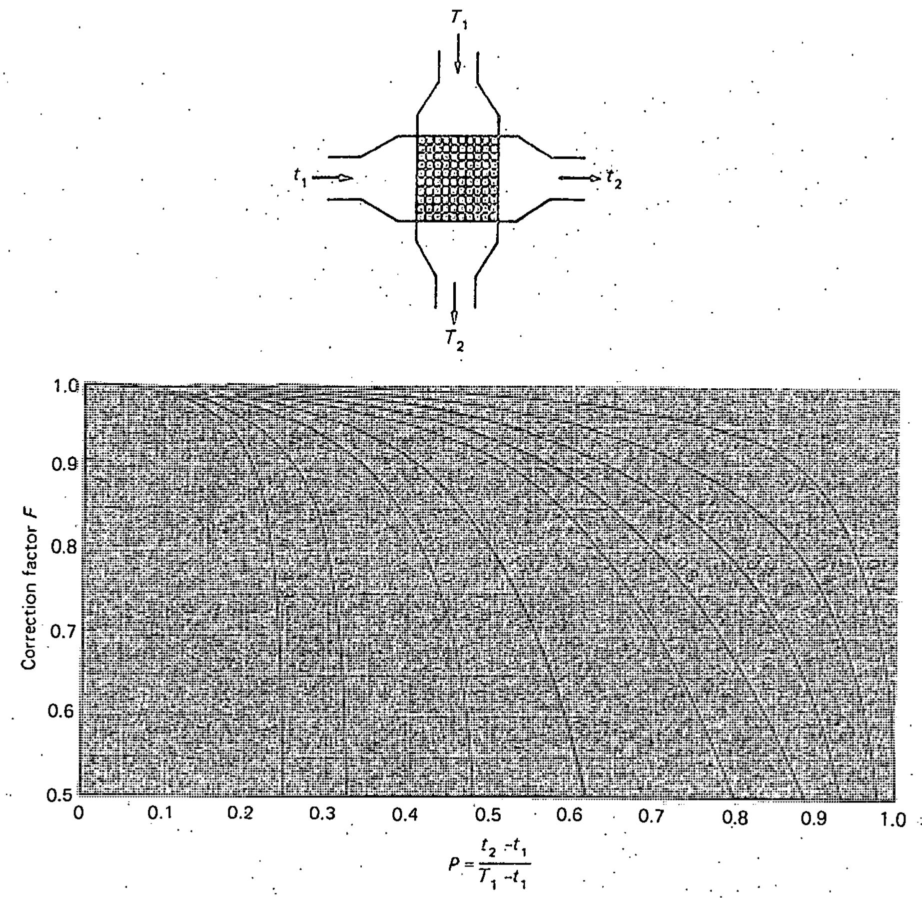
Table A-5 Properties of air at atmospheric pressure†

The values of μ, k, c_p, and Pr are not strongly pressure-dependent and may be used over a fairly wide range of pressures.

T, K	ρ kg/m³	c_p, kJ/kg·°C	μ, kg/m·s × 10^5	ν, m²/s × 10^6	k, W/m·°C	α, m²/s × 10^4	Pr
100	3.6010	1.0266	0.6924	1.923	0.009246	0.02501	0.770
150	2.3675	1.0099	1.0283	4.343	0.013735	0.05745	0.753
200	1.7684	1.0061	1.3289	7.490	0.01809	0.10165	0.739
250	1.4128	1.0053	1.5990	11.31	0.02227	0.15675	0.722
300	1.1774	1.0057	1.8462	15.69	0.02624	0.22160	0.708
350	0.9980	1.0090	2.075	20.76	0.03003	0.2983	0.697
400	0.8826	1.0140	2.286	25.90	0.03365	0.3760	0.689
450	0.7833	1.0207	2.484	31.71	0.03707	0.4222	0.683
500	0.7048	1.0295	2.671	37.90	0.04038	0.5564	0.680
550	0.6423	1.0392	2.848	44.34	0.04360	0.6532	0.680
600	0.5879	1.0551	3.018	51.34	0.04659	0.7512	0.680
650	0.5430	1.0635	3.177	58.51	0.04953	0.8578	0.682
700	0.5030	1.0752	3.332	66.25	0.05230	0.9672	0.684
750	0.4709	1.0856	3.481	73.91	0.05509	1.0774	0.686
800	0.4405	1.0978	3.625	82.29	0.05779	1.1951	0.689
850	0.4149	1.1095	3.765	90.75	0.06028	1.3097	0.692
900	0.3925	1.1212	3.899	99.3	0.06279	1.4271	0.696
950	0.3716	1.1321	4.023	108.2	0.06525	1.5510	0.699
1000	0.3524	1.1417	4.152	117.8	0.06752	1.6779	0.702
1100	0.3204	1.160	4.44	138.6	0.0732	1.969	0.704
1200	0.2947	1.179	4.69	159.1	0.0782	2.251	0.707
1300	0.2707	1.197	4.93	182.1	0.0837	2.583	0.705
1400	0.2515	1.214	5.17	205.5	0.0891	2.920	0.705
1500	0.2355	1.230	5.40	229.1	0.0946	3.262	0.705
1600	0.2211	1.248	5.63	254.5	0.100	3.609	0.705
1700	0.2082	1.267	5.85	280.5	0.105	3.977	0.705
1800	0.1970	1.287	6.07	308.1	0.111	4.379	0.704
1900	0.1858	1.309	6.29	338.5	0.117	4.811	0.704
2000	0.1762	1.338	6.50	369.0	0.124	5.260	0.702
2100	0.1682	1.372	6.72	399.6	0.131	5.715	0.700
2200	0.1602	1.419	6.93	432.6	0.139	6.120	0.707
2300	0.1538	1.482	7.14	464.0	0.149	6.540	0.710
2400	0.1458	1.574	7.35	504.0	0.161	7.020	0.718
2500	0.1394	1.688	7.57	543.5	0.175	7.441	0.730

† From *Natl. Bur. Stand. (U.S.) Circ.* 564, 1955.

Fig. 10-18 Correction-factor plot for single-pass cross-flow exchanger, both fluids unmixed.



Nu number for Vertical Rectangular Enclosures

$$Nu = 0.18\left(\frac{Pr}{0.2 + Pr} Ra_L\right)^{0.29}$$

$1 < H/L < 2$
any Prandtl number
$Ra_L\, Pr/(0.2 + Pr) > 10^3$

$$Nu = 0.22\left(\frac{Pr}{0.2 + Pr} Ra_L\right)^{0.28}\left(\frac{H}{L}\right)^{-1/4}$$

$2 < H/L < 10$
any Prandtl number
$Ra_L < 10^{10}$

$$Nu = 0.42\, Ra_L^{1/4}\, Pr^{0.012}\left(\frac{H}{L}\right)^{-0.3}$$

$10 < H/L < 40$
$1 < Pr < 2 \times 10^4$
$10^4 < Ra_L < 10^7$

$$Nu = 0.46 Ra_L^{1/3}$$

$1 < H/L < 40$
$1 < Pr < 20$
$10^6 < Ra_L < 10^9$

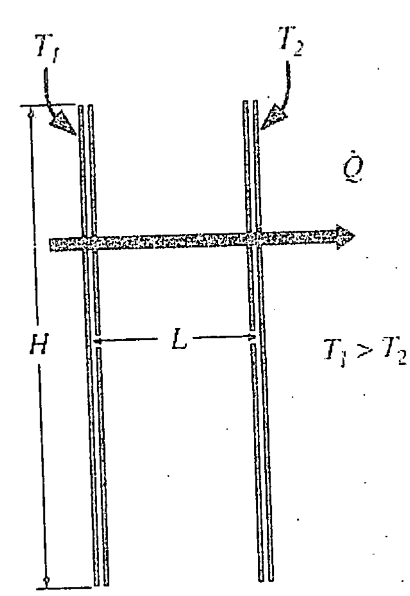


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Table 8-1 Radiation functions

λT		$E_{b\lambda}/T^5$		
μm·°R	μm·K	$\frac{\text{Btu}}{\text{h}\cdot\text{ft}^2\cdot{}^\circ\text{R}^5\cdot\mu\text{m}} \times 10^{15}$	$\frac{\text{W}}{\text{m}^2\cdot\text{K}^5\cdot\mu\text{m}} \times 10^{11}$	$\frac{E_{b_{0-\lambda T}}}{\sigma T^4}$
1,000	555.6	0.000671	0.400×10^{-5}	0.170×10^{-7}
1,200	666.7	0.0202	0.120×10^{-3}	0.756×10^{-6}
1,400	777.8	0.204	0.00122	0.106×10^{-4}
1,600	888.9	1.057	0.00630	0.738×10^{-4}
1,800	1,000.0	3.544	0.02111	0.321×10^{-3}
2,000	1,111.1	8.822	0.05254	0.00101
2,200	1,222.2	17.776	0.10587	0.00252
2,400	1,333.3	30.686	0.18275	0.00531
2,600	1,444.4	47.167	0.28091	0.00983
2,800	1,555.6	66.334	0.39505	0.01643
3,000	1,666.7	87.047	0.51841	0.02537
3,200	1,777.8	108.14	0.64404	0.03677
3,400	1,888.9	128.58	0.76578	0.05059
3,600	2,000.0	147.56	0.87878	0.06672
3,800	2,111.1	164.49	0.97963	0.08496
10,600	5,888.9	84.394	0.50261	0.72813
10,800	6,000.0	80.777	0.48107	0.73777
11,000	6,111.1	77.325	0.46051	0.74700
11,200	6,222.2	74.031	0.44089	0.75583
11,400	6,333.3	70.889	0.42218	0.76429
11,600	6,444.4	67.892	0.40434	0.77238
11,800	6,555.6	65.036	0.38732	0.78014
12,000	6,666.7	62.313	0.37111	0.78757
12,200	6,777.8	59.717	0.35565	0.79469
12,400	6,888.9	57.242	0.34091	0.80152
12,600	7,000.0	54.884	0.32687	0.80806
12,800	7,111.1	52.636	0.31348	0.81433
13,000	7,222.2	50.493	0.30071	0.82035
13,200	7,333.3	48.450	0.28855	0.82612
13,400	7,444.4	46.502	0.27695	0.83166
13,600	7,555.6	44.645	0.26589	0.83698
13,800	7,666.7	42.874	0.25534	0.84209
14,000	7,777.8	41.184	0.24527	0.84699
14,200	7,888.9	39.572	0.23567	0.85171
14,400	8,000.0	38.033	0.22651	0.85624
14,600	8,111.1	36.565	0.21777	0.86059
14,800	8,222.2	35.163	0.20942	0.86477
15,000	8,333.3	33.825	0.20145	0.86880
16,000	8,888.9	27.977	0.16662	0.88677
17,000	9,444.4	23.301	0.13877	0.90168
18,000	10,000.0	19.536	0.11635	0.91414
19,000	10,555.6	16.484	0.09817	0.92462
20,000	11,111.1	13.994	0.08334	0.93349
21,000	11,666.7	11.949	0.07116	0.94104
22,000	12,222.2	10.258	0.06109	0.94751
23,000	12,777.8	8.852	0.05272	0.95307
24,000	13,333.3	7.676	0.04572	0.95788
25,000	13,888.9	6.687	0.03982	0.96207
26,000	14,444.4	5.850	0.03484	0.96572
27,000	15,000.0	5.139	0.03061	0.96892
28,000	15.555.6	4.532	0.02699	0.97174
29,000	16,111.1	4.012	0.02389	0.97423
30,000	16,666.7	3.563	0.02122	0.97644
40,000	22,222.2	1.273	0.00758	0.98915
50,000	27,777.8	0.560	0.00333	0.99414
60,000	33,333.3	0.283	0.00168	0.99649
70,000	38,888.9	0.158	0.940×10^{-3}	0.99773
80,000	44,444.4	0.0948	0.564×10^{-3}	0.99845
90,000	50,000.0	0.0603	0.359×10^{-3}	0.99889
100,000	55,555.6	0.0402	0.239×10^{-3}	0.99918

TABLE A-5

Saturated water—Pressure table

Press., P kPa	Sat. temp., T_{sat} °C	Specific volume, m³/kg: Sat. liquid, v_f	Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Enthalpy, kJ/kg: Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g	Entropy, kJ/kg · K: Sat. liquid, s_f	Evap., s_{fg}	Sat. vapor, s_g
1.0	6.97	0.001000	129.19	29.302	2355.2	2384.5	29.303	2484.4	2513.7	0.1059	8.8690	8.9749
1.5	13.02	0.001001	87.964	54.686	2338.1	2392.8	54.688	2470.1	2524.7	0.1956	8.6314	8.8270
2.0	17.50	0.001001	66.990	73.431	2325.5	2398.9	73.433	2459.5	2532.9	0.2606	8.4621	8.7227
2.5	21.08	0.001002	54.242	88.422	2315.4	2403.8	88.424	2451.0	2539.4	0.3118	8.3302	8.6421
3.0	24.08	0.001003	45.654	100.98	2306.9	2407.9	100.98	2443.9	2544.8	0.3543	8.2222	8.5765
4.0	28.96	0.001004	34.791	121.39	2293.1	2414.5	121.39	2432.3	2553.7	0.4224	8.0510	8.4734
5.0	32.87	0.001005	28.185	137.75	2282.1	2419.8	137.75	2423.0	2560.7	0.4762	7.9176	8.3938
7.5	40.29	0.001008	19.233	168.74	2261.1	2429.8	168.75	2405.3	2574.0	0.5763	7.6738	8.2501
10	45.81	0.001010	14.670	191.79	2245.4	2437.2	191.81	2392.1	2583.9	0.6492	7.4996	8.1488
15	53.97	0.001014	10.020	225.93	2222.1	2448.0	225.94	2372.3	2598.3	0.7549	7.2522	8.0071
20	60.06	0.001017	7.6481	251.40	2204.6	2456.0	251.42	2357.5	2608.9	0.8320	7.0752	7.9073
25	64.96	0.001020	6.2034	271.93	2190.4	2462.4	271.96	2345.5	2617.5	0.8932	6.9370	7.8302
30	69.09	0.001022	5.2287	289.24	2178.5	2467.7	289.27	2335.3	2624.6	0.9441	6.8234	7.7675
40	75.86	0.001026	3.9933	317.58	2158.8	2476.3	317.62	2318.4	2636.1	1.0261	6.6430	7.6691
50	81.32	0.001030	3.2403	340.49	2142.7	2483.2	340.54	2304.7	2645.2	1.0912	6.5019	7.5931
75	91.76	0.001037	2.2172	384.36	2111.8	2496.1	384.44	2278.0	2662.4	1.2132	6.2426	7.4558
100	99.61	0.001043	1.6941	417.40	2088.2	2505.6	417.51	2257.5	2675.0	1.3028	6.0562	7.3589
101.325	99.97	0.001043	1.6734	418.95	2087.0	2506.0	419.06	2256.5	2675.6	1.3069	6.0476	7.3545
125	105.97	0.001048	1.3750	444.23	2068.8	2513.0	444.36	2240.6	2684.9	1.3741	5.9100	7.2841
150	111.35	0.001053	1.1594	466.97	2052.3	2519.2	467.13	2226.0	2693.1	1.4337	5.7894	7.2231
175	116.04	0.001057	1.0037	486.82	2037.7	2524.5	487.01	2213.1	2700.2	1.4850	5.6865	7.1716
200	120.21	0.001061	0.88578	504.50	2024.6	2529.1	504.71	2201.6	2706.3	1.5302	5.5968	7.1270
225	123.97	0.001064	0.79329	520.47	2012.7	2533.2	520.71	2191.0	2711.7	1.5706	5.5171	7.0877
250	127.41	0.001067	0.71873	535.08	2001.8	2536.8	535.35	2181.2	2716.5	1.6072	5.4453	7.0525
275	130.58	0.001070	0.65732	548.57	1991.6	2540.1	548.86	2172.0	2720.9	1.6408	5.3800	7.0207
300	133.52	0.001073	0.60582	561.11	1982.1	2543.2	561.43	2163.5	2724.9	1.6717	5.3200	6.9917
325	136.27	0.001076	0.56199	572.84	1973.1	2545.9	573.19	2155.4	2728.6	1.7005	5.2645	6.9650
350	138.86	0.001079	0.52422	583.89	1964.6	2548.5	584.26	2147.7	2732.0	1.7274	5.2128	6.9402
375	141.30	0.001081	0.49133	594.32	1956.6	2550.9	594.73	2140.4	2735.1	1.7526	5.1645	6.9171
400	143.61	0.001084	0.46242	604.22	1948.9	2553.1	604.66	2133.4	2738.1	1.7765	5.1191	6.8955
450	147.90	0.001088	0.41392	622.65	1934.5	2557.1	623.14	2120.3	2743.4	1.8205	5.0356	6.8561
500	151.83	0.001093	0.37483	639.54	1921.2	2560.7	640.09	2108.0	2748.1	1.8604	4.9603	6.8207
550	155.46	0.001097	0.34261	655.16	1908.8	2563.9	655.77	2096.6	2752.4	1.8970	4.8916	6.7886
600	158.83	0.001101	0.31560	669.72	1897.1	2566.8	670.38	2085.8	2756.2	1.9308	4.8285	6.7593
650	161.98	0.001104	0.29260	683.37	1886.1	2569.4	684.08	2075.5	2759.6	1.9623	4.7699	6.7322
700	164.95	0.001108	0.27278	696.23	1875.6	2571.8	697.00	2065.8	2762.8	1.9918	4.7153	6.7071
750	167.75	0.001111	0.25552	708.40	1865.6	2574.0	709.24	2056.4	2765.7	2.0195	4.6642	6.6837

TABLE A-5

Saturated water—Pressure table (*Continued*)

Press., P kPa	Sat. temp., T_{sat} °C	Specific volume, m³/kg: Sat. liquid, v_f	Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Enthalpy, kJ/kg: Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g	Entropy, kJ/kg · K: Sat. liquid, s_f	Evap., s_{fg}	Sat. vapor, s_g
800	170.41	0.001115	0.24035	719.97	1856.1	2576.0	720.87	2047.5	2768.3	2.0457	4.6160	6.6616
850	172.94	0.001118	0.22690	731.00	1846.9	2577.9	731.95	2038.8	2770.8	2.0705	4.5705	6.6409
900	175.35	0.001121	0.21489	741.55	1838.1	2579.6	742.56	2030.5	2773.0	2.0941	4.5273	6.6213
950	177.66	0.001124	0.20411	751.67	1829.6	2581.3	752.74	2022.4	2775.2	2.1166	4.4862	6.6027
1000	179.88	0.001127	0.19436	761.39	1821.4	2582.8	762.51	2014.6	2777.1	2.1381	4.4470	6.5850
1100	184.06	0.001133	0.17745	779.78	1805.7	2585.5	781.03	1999.6	2780.7	2.1785	4.3735	6.5520
1200	187.96	0.001138	0.16326	796.96	1790.9	2587.8	798.33	1985.4	2783.8	2.2159	4.3058	6.5217
1300	191.60	0.001144	0.15119	813.10	1776.8	2589.9	814.59	1971.9	2786.5	2.2508	4.2428	6.4936
1400	195.04	0.001149	0.14078	828.35	1763.4	2591.8	829.96	1958.9	2788.9	2.2835	4.1840	6.4675
1500	198.29	0.001154	0.13171	842.82	1750.6	2593.4	844.55	1946.4	2791.0	2.3143	4.1287	6.4430
1750	205.72	0.001166	0.11344	876.12	1720.6	2596.7	878.16	1917.1	2795.2	2.3844	4.0033	6.3877
2000	212.38	0.001177	0.099587	906.12	1693.0	2599.1	908.47	1889.8	2798.3	2.4467	3.8923	6.3390
2250	218.41	0.001187	0.088717	933.54	1667.3	2600.9	936.21	1864.3	2800.5	2.5029	3.7926	6.2954
2500	223.95	0.001197	0.079952	958.87	1643.2	2602.1	961.87	1840.1	2801.9	2.5542	3.7016	6.2558
3000	233.85	0.001217	0.066667	1004.6	1598.5	2603.2	1008.3	1794.9	2803.2	2.6454	3.5402	6.1856
3500	242.56	0.001235	0.057061	1045.4	1557.6	2603.0	1049.7	1753.0	2802.7	2.7253	3.3991	6.1244
4000	250.35	0.001252	0.049779	1082.4	1519.3	2601.7	1087.4	1713.5	2800.8	2.7966	3.2731	6.0696
5000	263.94	0.001286	0.039448	1148.1	1448.9	2597.0	1154.5	1639.7	2794.2	2.9207	3.0530	5.9737
6000	275.59	0.001319	0.032449	1205.8	1384.1	2589.9	1213.8	1570.9	2784.6	3.0275	2.8627	5.8902
7000	285.83	0.001352	0.027378	1258.0	1323.0	2581.0	1267.5	1505.2	2772.6	3.1220	2.6927	5.8148
8000	295.01	0.001384	0.023525	1306.0	1264.5	2570.5	1317.1	1441.6	2758.7	3.2077	2.5373	5.7450
9000	303.35	0.001418	0.020489	1350.9	1207.6	2558.5	1363.7	1379.3	2742.9	3.2866	2.3925	5.6791
10,000	311.00	0.001452	0.018028	1393.3	1151.8	2545.2	1407.8	1317.6	2725.5	3.3603	2.2556	5.6159
11,000	318.08	0.001488	0.015988	1433.9	1096.6	2530.4	1450.2	1256.1	2706.3	3.4299	2.1245	5.5544
12,000	324.68	0.001526	0.014264	1473.0	1041.3	2514.3	1491.3	1194.1	2685.4	3.4964	1.9975	5.4939
13,000	330.85	0.001566	0.012781	1511.0	985.5	2496.6	1531.4	1131.3	2662.7	3.5606	1.8730	5.4336
14,000	336.67	0.001610	0.011487	1548.4	928.7	2477.1	1571.0	1067.0	2637.9	3.6232	1.7497	5.3728
15,000	342.16	0.001657	0.010341	1585.5	870.3	2455.7	1610.3	1000.5	2610.8	3.6848	1.6261	5.3108
16,000	347.36	0.001710	0.009312	1622.6	809.4	2432.0	1649.9	931.1	2581.0	3.7461	1.5005	5.2466
17,000	352.29	0.001770	0.008374	1660.2	745.1	2405.4	1690.3	857.4	2547.7	3.8082	1.3709	5.1791
18,000	356.99	0.001840	0.007504	1699.1	675.9	2375.0	1732.2	777.8	2510.0	3.8720	1.2343	5.1064
19,000	361.47	0.001926	0.006677	1740.3	598.9	2339.2	1776.8	689.2	2466.0	3.9396	1.0860	5.0256
20,000	365.75	0.002038	0.005862	1785.8	509.0	2294.8	1826.6	585.5	2412.1	4.0146	0.9164	4.9310
21,000	369.83	0.002207	0.004994	1841.6	391.9	2233.5	1888.0	450.4	2338.4	4.1071	0.7005	4.8076
22,000	373.71	0.002703	0.003644	1951.7	140.8	2092.4	2011.1	161.5	2172.6	4.2942	0.2496	4.5439
22,064	373.95	0.003106	0.003106	2015.7	0	2015.7	2084.3	0	2084.3	4.4070	0	4.4070

ME 265

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TABLE A-6

Superheated water (*Concluded*)

T °C	*v* m³/kg	*u* kJ/kg	*h* kJ/kg	*s* kJ/kg · K	*v* m³/kg	*u* kJ/kg	*h* kJ/kg	*s* kJ/kg · K	*v* m³/kg	*u* kJ/kg	*h* kJ/kg	*s* kJ/kg · K
	P = 15.0 MPa (342.16°C)				*P* = 17.5 MPa (354.67°C)				*P* = 20.0 MPa (365.75°C)			
Sat.	0.010341	2455.7	2610.8	5.3108	0.007932	2390.7	2529.5	5.1435	0.005862	2294.8	2412.1	4.9310
350	0.011481	2520.9	2693.1	5.4438								
400	0.015671	2740.6	2975.7	5.8819	0.012463	2684.3	2902.4	5.7211	0.009950	2617.9	2816.9	5.5526
450	0.018477	2880.8	3157.9	6.1434	0.015204	2845.4	3111.4	6.0212	0.012721	2807.3	3061.7	5.9043
500	0.020828	2998.4	3310.8	6.3480	0.017385	2972.4	3276.7	6.2424	0.014793	2945.3	3241.2	6.1446
550	0.022945	3106.2	3450.4	6.5230	0.019305	3085.8	3423.6	6.4266	0.016571	3064.7	3396.2	6.3390
600	0.024921	3209.3	3583.1	6.6796	0.021073	3192.5	3561.3	6.5890	0.018185	3175.3	3539.0	6.5075
650	0.026804	3310.1	3712.1	6.8233	0.022742	3295.8	3693.8	6.7366	0.019695	3281.4	3675.3	6.6593
700	0.028621	3409.8	3839.1	6.9573	0.024342	3397.5	3823.5	6.8735	0.021134	3385.1	3807.8	6.7991
800	0.032121	3609.3	4091.1	7.2037	0.027405	3599.7	4079.3	7.1237	0.023870	3590.1	4067.5	7.0531
900	0.035503	3811.2	4343.7	7.4288	0.030348	3803.5	4334.6	7.3511	0.026484	3795.7	4325.4	7.2829
1000	0.038808	4017.1	4599.2	7.6378	0.033215	4010.7	4592.0	7.5616	0.029020	4004.3	4584.7	7.4950
1100	0.042062	4227.7	4858.6	7.8339	0.036029	4222.3	4852.8	7.7588	0.031504	4216.9	4847.0	7.6933
1200	0.045279	4443.1	5122.3	8.0192	0.038806	4438.5	5117.6	7.9449	0.033952	4433.8	5112.9	7.8802
1300	0.048469	4663.3	5390.3	8.1952	0.041556	4659.2	5386.5	8.1215	0.036371	4655.2	5382.7	8.0574
	P = 25.0 MPa				*P* = 30.0 MPa				*P* = 35.0 MPa			
375	0.001978	1799.9	1849.4	4.0345	0.001792	1738.1	1791.9	3.9313	0.001701	1702.8	1762.4	3.8724
400	0.006005	2428.5	2578.7	5.1400	0.002798	2068.9	2152.8	4.4758	0.002105	1914.9	1988.6	4.2144
425	0.007886	2607.8	2805.0	5.4708	0.005299	2452.9	2611.8	5.1473	0.003434	2253.3	2373.5	4.7751
450	0.009176	2721.2	2950.6	5.6759	0.006737	2618.9	2821.0	5.4422	0.004957	2497.5	2671.0	5.1946
500	0.011143	2887.3	3165.9	5.9643	0.008691	2824.0	3084.8	5.7956	0.006933	2755.3	2997.9	5.6331
550	0.012736	3020.8	3339.2	6.1816	0.010175	2974.5	3279.7	6.0403	0.008348	2925.8	3218.0	5.9093
600	0.014140	3140.0	3493.5	6.3637	0.011445	3103.4	3446.8	6.2373	0.009523	3065.6	3399.0	6.1229
650	0.015430	3251.9	3637.7	6.5243	0.012590	3221.7	3599.4	6.4074	0.010565	3190.9	3560.7	6.3030
700	0.016643	3359.9	3776.0	6.6702	0.013654	3334.3	3743.9	6.5599	0.011523	3308.3	3711.6	6.4623
800	0.018922	3570.7	4043.8	6.9322	0.015628	3551.2	4020.0	6.8301	0.013278	3531.6	3996.3	6.7409
900	0.021075	3780.2	4307.1	7.1668	0.017473	3764.6	4288.8	7.0695	0.014904	3749.0	4270.6	6.9853
1000	0.023150	3991.5	4570.2	7.3821	0.019240	3978.6	4555.8	7.2880	0.016450	3965.8	4541.5	7.2069
1100	0.025172	4206.1	4835.4	7.5825	0.020954	4195.2	4823.9	7.4906	0.017942	4184.4	4812.4	7.4118
1200	0.027157	4424.6	5103.5	7.7710	0.022630	4415.3	5094.2	7.6807	0.019398	4406.1	5085.0	7.6034
1300	0.029115	4647.2	5375.1	7.9494	0.024279	4639.2	5367.6	7.8602	0.020827	4631.2	5360.2	7.7841
	P = 40.0 MPa				*P* = 50.0 MPa				*P* = 60.0 MPa			
375	0.001641	1677.0	1742.6	3.8290	0.001560	1638.6	1716.6	3.7642	0.001503	1609.7	1699.9	3.7149
400	0.001911	1855.0	1931.4	4.1145	0.001731	1787.8	1874.4	4.0029	0.001633	1745.2	1843.2	3.9317
425	0.002538	2097.5	2199.0	4.5044	0.002009	1960.3	2060.7	4.2746	0.001816	1892.9	2001.8	4.1630
450	0.003692	2364.2	2511.8	4.9449	0.002487	2160.3	2284.7	4.5896	0.002086	2055.1	2180.2	4.4140
500	0.005623	2681.6	2906.5	5.4744	0.003890	2528.1	2722.6	5.1762	0.002952	2393.2	2570.3	4.9356
550	0.006985	2875.1	3154.4	5.7857	0.005118	2769.5	3025.4	5.5563	0.003955	2664.6	2901.9	5.3517
600	0.008089	3026.8	3350.4	6.0170	0.006108	2947.1	3252.6	5.8245	0.004833	2866.8	3156.8	5.6527
650	0.009053	3159.5	3521.6	6.2078	0.006957	3095.6	3443.5	6.0373	0.005591	3031.3	3366.8	5.8867
700	0.009930	3282.0	3679.2	6.3740	0.007717	3228.7	3614.6	6.2179	0.006265	3175.4	3551.3	6.0814
800	0.011521	3511.8	3972.6	6.6613	0.009073	3472.2	3925.8	6.5225	0.007456	3432.6	3880.0	6.4033
900	0.012980	3733.3	4252.5	6.9107	0.010296	3702.0	4216.8	6.7819	0.008519	3670.9	4182.1	6.6725
1000	0.014360	3952.9	4527.3	7.1355	0.011441	3927.4	4499.4	7.0131	0.009504	3902.0	4472.2	6.9099
1100	0.015686	4173.7	4801.1	7.3425	0.012534	4152.2	4778.9	7.2244	0.010439	4130.9	4757.3	7.1255
1200	0.016976	4396.9	5075.9	7.5357	0.013590	4378.6	5058.1	7.4207	0.011339	4360.5	5040.8	7.3248
1300	0.018239	4623.3	5352.8	7.7175	0.014620	4607.5	5338.5	7.6048	0.012213	4591.8	5324.5	7.5111

L-2/T-2/IPE **Date : 20/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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 nominal-level data and ordinal-level data. **(14)**

   (b) Explain the frequency polygon and cumulative frequency distribution. **(12)**

   (c) An MBA applies for a job in the two firms, X and Y. The probability of his being selected in firm X is 0.7 and of being rejected in firm Y is 0.5. The probability at least one of his applications being rejected is 0.6. What is the probability that he will be selected in one of the firms? **($15\frac{2}{3}$)**

   (d) Mean is unduly affected by unusually large or small values. Explain. **(5)**

2. (a) A manufacturing firm is engaged in the production of steel pipes in its three plants with a daily production of 1000, 1500 and 2500 units respectively. According to the past experience, it is known that the fractions of defective pipes produced by the three plants are respectively 0.04, 0.09 and 0.07. If a pipe is selected from a day's total production and found to be defective, find out (i) from which plant the defective pipe has come, and (ii) what is the probability that it has come from the second plant? **(16)**

   (b) In a certain locality, half of the households is known to use a particular brand of soap. In a household survey, samples of 10 households are allotted to each investigator and 2048 investigators are appointed for the survey. How many investigators are likely to report: (i) 3 users (ii) not more than 3 users, and (iii) at least 4 users? **($18\frac{2}{3}$)**

   (c) The probability distribution of x, the number of imperfections per 10 meters of a synthetic fabric is continuous rolls of uniform width, is given by **(12)**

x	0	1	2	3	4
f(x)	0.41	0.37	0.16	0.05	0.01

   Find the expected number of imperfections and variance.

3. (a) Explain the characteristics of Hypergeometric distribution. **(10)**

   (b) Prove that both the mean and variance of the Poisson distribution $P(X, \lambda t)$ are λt. **(20)**

   (c) For a binomial distribution, mean is 6 and standard deviation is $\sqrt{2}$, find n, p and q. **($16\frac{2}{3}$)**

4. (a) Describe the Cluster sampling method. **(12)**

   (b) Explain Central limit theorem. **(8)**

   (c) Assuming that the height distribution of a group of men is normal, find the mean and standard deviation, given that 84 percent of the men have height less than 65.2 inches and 68 percent have heights between 65.2 and 62.5 inches. **($14\frac{2}{3}$)**

   (d) The Crosselt Trucking company claims that the mean weight of their delivery trucks when they are fully loaded is 6000 pounds and the standard deviation is 150 pounds. Assume that the population follows the normal distribution. Forty trucks are randomly selected and weighed. Within what limits will 95 percent of the sample means occur? **(12)**

SECTION – B

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

Assume reasonable values for missing data if any.

5. (a) Describe the characteristics of the F distribution with necessary figures. **($10\frac{2}{3}$)**

   (b) Suppose, a consumer advocacy group would like to conduct a survey to find the proportion p of consumers who bought the newest generation of an MP3 player and were happy with their purchase. **(8+8)**

   (i) How large a sample n should they take to estimate p with 2% margin of error and 90% confidence?

   (ii) The advocacy group took a random sample of 1000 consumers who recently purchased this MP3 player and found that 400 were happy with their purchase. Find a 95% confidence interval for p.

   (c) A new casino game involves rolling 3 dice. The winnings are directly proportional to the total number of sixes rolled. Suppose a gambler plays the game 100 times, with the following observed counts: **(20)**

Number of Sixes	Number of Rolls
0	48
1	35
2	15
3	2

The casino becomes suspicious of the gambler and wishes to determine whether the dice are fair. What do you conclude on whether the dice are fair given that 3 dice are independent? Use the 0.05 significance level.

Contd P/3

IPE 207

6. (a) A study was made by a retail merchant to determine the relation between weekly advertising expenditures and sales. The following data were recorded:

Advertising Costs ($)	Sales ($)
40	385
20	400
25	395
20	365
30	475
50	440
40	490
20	420
50	560
40	525
25	480
50	510

Required:

(i) Find the equation of the regression line to predict weekly sales from advertising expenditures. Show all necessary calculations. **(15)**

(ii) Estimate the weekly sales when advertising costs are $35. **(5)**

(iii) Find the coefficient of determination, R^2. What conclusion can you draw from the value of R^2? **(5)**

(iv) Determine the confidence interval if the confidence level is set at 95%. Use the information of 6(i)-6(ii) to complete your calculation. **(5)**

(b) Let X be a random variable with the density function **($16\frac{2}{3}$)**

$$f(x) = x, \quad 0 < x < 1$$
$$= 0, \quad \text{otherwise}$$

Find the moment generating function for X.

7. (a) Recently airlines cut services, such as meals and snacks during flights, and started charging for checked luggage. A group of four carries hired some students from the Department of Industrial and Production Engineering (IPE) at Bangladesh University of Engineering and Technology (BUET) to survey passengers regarding their level of satisfaction with a recent flight. The survey included questions on ticketing, boarding, in-flight service, baggage handling, schedule maintaining, pilot communication, safety instructions, and so forth. Twenty-five questions offered a range of possible answers: excellent, good, fair, or poor. A response of excellent was given a score of 4, good a score of 3, fair a score of 2, and poor a score of 1. These responses were then totaled, so the total score was an indication of the satisfaction with the flight. The greater the score, the higher the level of satisfaction with the service. The highest possible score was 1000. The research group from the Department of Industrial and Production Engineering randomly selected and surveyed passengers from the four airlines. Below is the sample information. **(30)**

Contd P/4

IPE 207

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

Novo-X	United-X	Regent-Y	GMG-Y
94	75	70	68
90	68	73	70
85	77	76	72
80	83	78	65
	88	80	74
		68	65
		65	

Is there a difference in the mean satisfaction level among the four airlines? Use the 0.01 significance level.

(b) 'After ANOVA analysis, confidence intervals can be used to test and interpret differences between pairs of population means' – Do you agree with this statement? Justify your answer by picking and analyzing any two airlines information from 7(a). **($16\frac{2}{3}$)**

8. (a) The Edison Electric Institute has published figures on the annual number of kilowatt hours expended by various home appliances. It is claimed that a vacuum cleaner expends an average of 46 kilowatt hours per year. If a random sample of 12 homes included in a planned study indicates that vacuum cleaners expend an average of 42 kilowatt hours per year with a standard deviation of 11.9 kilowatt hours, does this suggest at the 0.05 level of significance that vacuum cleaners expend, on the average, less than 46 kilowatt hours annually? Assume the population of kilowatt hours to be normal. **($16\frac{2}{3}$)**

(b) A manufacturer has developed a new fishing line, which he claims has a mean breaking strength of 15 kilograms with a standard deviation of 0.5 kilogram. To test the hypothesis that p = 15 kilograms against the alternative that p < 15 kilograms, a random sample of 50 lines will be tested. The critical region is defined to be $\bar{x} < 14.9$. Find the probability of committing a type I error. **(15)**

(c) Mary Jo Fitzpatrick is the vice president for Nursing Services at St. Luke's Memorial Hospital. Recently she noticed in the job posting for nurses that those that are unionized seem to offer higher wages. She decided to investigate and gathered the following information. **(15)**

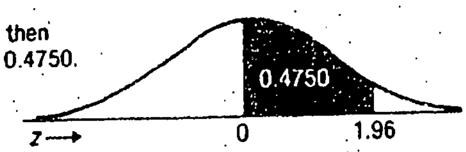
Group	Mean wage	Population standard deviation	Sample size
Union	\$20.75	\$2.25	40
Nonunion	\$19.80	\$1.90	45

Would it be reasonable for the vice president to conclude that union nurses earn more? Use the 0.02 significance level. What is the *p*-value?

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 interval — Left-tailed test — Right-tailed test — Two-tailed test

	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	2.554	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

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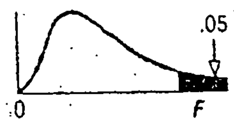
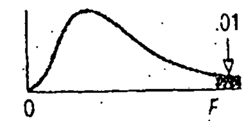
B.4 Critical Values of the *F* Distribution at a 5 Percent Level of Significance



Degrees of Freedom for the Numerator (columns); Degrees of Freedom for the Denominator (rows)

	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	4.86	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	[illegible]
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

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



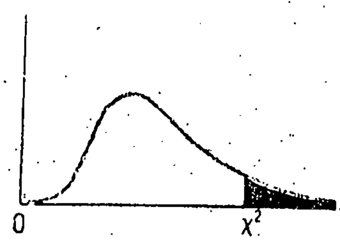
Degrees of Freedom for the Numerator (columns); Degrees of Freedom for the Denominator (rows)

	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	10.5	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

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 : 26/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning. Assume any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) A fabric used in air-inflated structures shown in Fig. 1(a) is subjected to a biaxial loading that results in normal stresses $\sigma_x = 120$ MPa and $\sigma_z = 160$ MPa. Knowing that the properties of the fabric can be approximated as E = 87 GPa and $\nu = 0.34$, determine the change in length of (i) side AB, (ii) side BC. **(18)**

   (b) A 5/8-in. diameter steel rod AB is fitted to a round hole near C of the wooden member CD as shown in Fig. 1(b). For the loading shown, determine **(17)**

   (i) the maximum average normal stress in the wood,

   (ii) the distance b for which the average shearing stress is 100 psi on the surfaces indicated by the dashed lines,

   (iii) the average bearing stress on the wood.

2. (a) A hollow aluminum tube used in a roof structure has an outside diameter $d_2 = 100$ mm and an inside diameter $d_1 = 80$ mm as shown in Fig. 2(a). The tube is 2.5 m long and the aluminum has shear modulus G = 28 GPa. **(20)**

   (i) If the tube is twisted in pure torsion by torques acting at the ends, what is the angle of twist ϕ (in degree) when the maximum shear stress is 50 MPa?

   (ii) What diameter d is required for a solid shaft to resist the same torque with the same maximum stress?

   (iii) What is the ratio of the weight of the hollow tube to the weight of the solid shaft?

   (b) To prevent damage to the engine and propeller of a tugboat, a short auxiliary shaft is placed between the main shaft and the propeller shaft to act as a safety valve. If the main and propeller shafts are each 6 in. in diameter and the auxiliary is 5 in. in diameter, how many 1-in. bolts are required in each coupling if the bolt circle is 12 in. in diameter and the maximum torque to be restrained is computed on the basis of a proportional limit stress of 24,000 psi being attained in the auxiliary shaft? The shearing unit stress in bolts is 10,000 psi. **(15)**

Contd P/2

3. (a) Column ABC has a uniform rectangular cross-section and is braced in the xz plane at its midspan C as shown in Fig. 3(a). **(18)**

   (i) Determine the ratio b/d for which the factor of safety is the same with respect to buckling in the xz and yz planes.

   (ii) Using the ratio found in part (i), design the cross-section of the column so that the factor of safety will be 3.0 when P = 4.4 kN, L = 1 m and E = 200 GPa.

   (b) The uniform column AB consists of an 8-ft section of structural tubing having the cross-section shown in Fig. 3(b). **(17)**

   (i) Using a factor of safety of two, determine the allowable centric load for the column and the corresponding normal stress.

   (ii) Assuming that the allowable load, found in part (i), is applied at a point 0.75 in. from the geometric axis of the column, determine the horizontal deflection of the top of the column and the maximum normal stress in the column. (Use $E = 29 \times 10^6$ psi)

4. (a) Show that "the sum of the normal stresses acting on perpendicular faces of plane-stress elements (at a given point in a stressed body) is constant and independent of the angle of inclination of the plane". **(17)**

   (b) An element in pure shear is subjected to stresses τ_{xy} = 4000 psi as shown in Fig. 4(b). Using Mohr's circle, determine **(18)**

   (i) the stresses acting on an element oriented at a slope of 3 on 4,

   (ii) the principal stresses,

   (iii) the maximum shear stresses.

   Show all results on sketches of properly oriented elements.

SECTION – B

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

5. (a) Draw the shear force and bending moment diagrams for the beam shown in Fig. 5(a). Specify values of shear force and bending moment at all change of loading positions and at all points of zero shear. (Neglect the weight of the beam) **(17)**

   (b) A wide-flange section of a beam having the dimensions as shown in Fig. 5(b) supports a distributed load of w_0 N/m on a simple span of length L m. Determine the ratio of the maximum flexure stress to the maximum shear stress. **(18)**

6. (a) Using the double integration method, determine the maximum value of deflection for the cantilever beam loaded as shown in Fig. 6(a). **(17)**

   (b) A simply supported beam is subjected to the loading as shown in Fig. 6(b). Determine the deflection of the beam at the point of application of the 200 N-m couple. Use area moment method. **(18)**

7. (a) A crane hook of rectangular cross-section supports a load P = 40 kN as shown in Fig. 7(a). Determine the maximum and minimum normal stresses at section *a-a*. Use curved beam theory to solve the problem. **(17)**

   (b) Determine the width and required steel area for a reinforced concrete beam with balanced-stress reinforcement that will resist a bending moment of 140 kN.m. Assume $d = 1.5b$, $f_c = 12$ MPa, $f_s = 160$ MPa and $n = 8$. **(18)**

8. (a) Two thick-walled cylinders of the same dimensions, outer diameter being twice the inner diameter, are subjected to fluid pressure. One cylinder is subjected to internal fluid pressure and the other is subjected to external fluid pressure. Determine the ratio of pressures if the magnitude of the maximum tangential stress of each cylinder is the same. **(17)**

   (b) A pipe carrying steam at 3.5 MPa has an outside diameter of 450 mm and a wall thickness of 10 mm. A gasket is inserted between the flange at one end of the pipe and a flat plate used to cap the end. How many 40 mm diameter bolts must be used to hold the cap if the allowable stress in the bolts is 80 MPa, of which 55 MPa is the initial stress? What circumferential stress is developed in the pipe? **(18)**

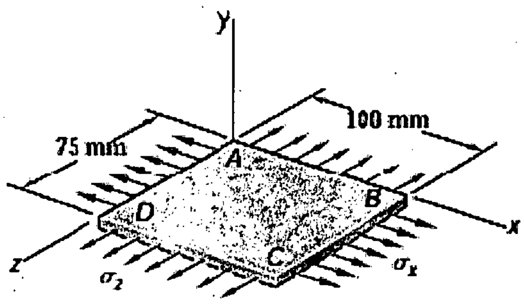


Figure for Que. No. 1(a)

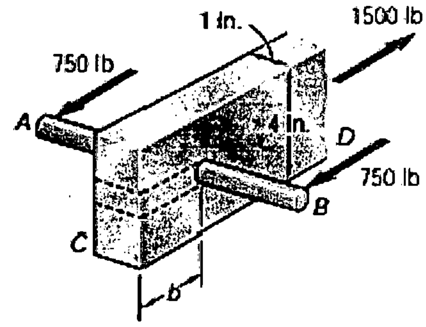


Figure for Que. No. 1(b)

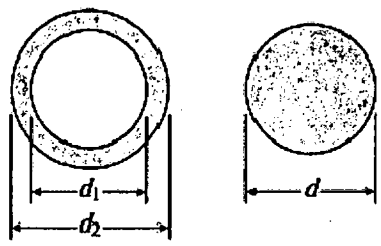


Figure for Que. No. 2(a)

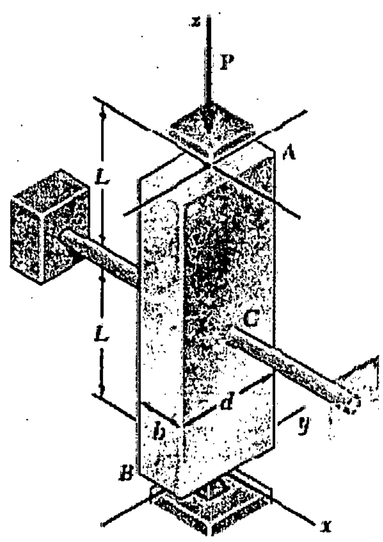


Figure for Que. No. 3(a)

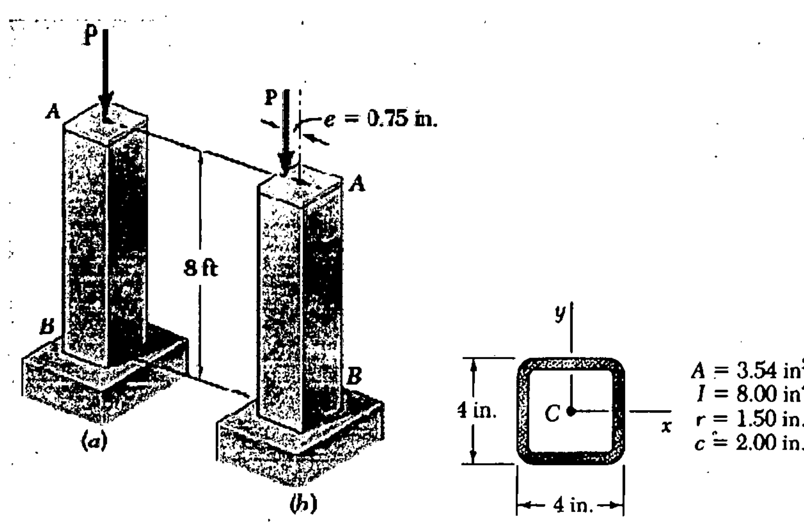


Figure for Que. No. 3(b)

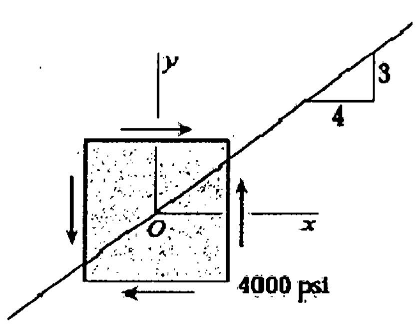


Figure for Que. No. 4(b)

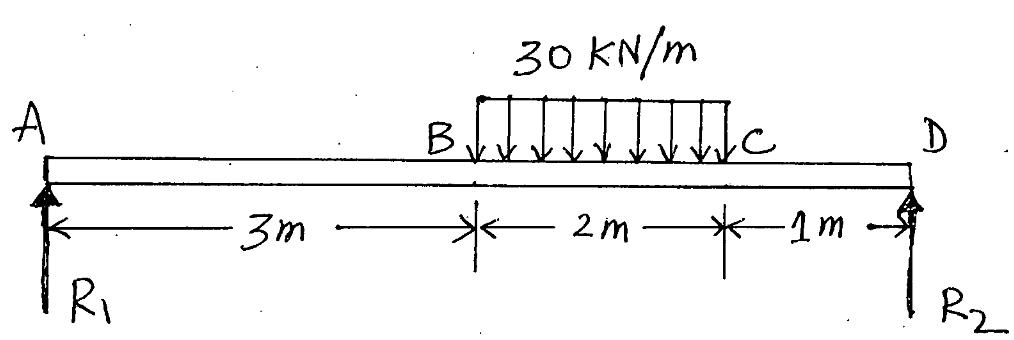


Fig. 5(a)

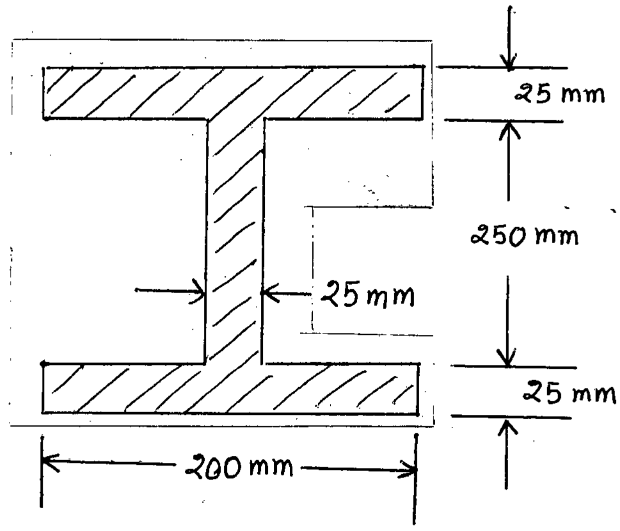


Fig. 5(b)

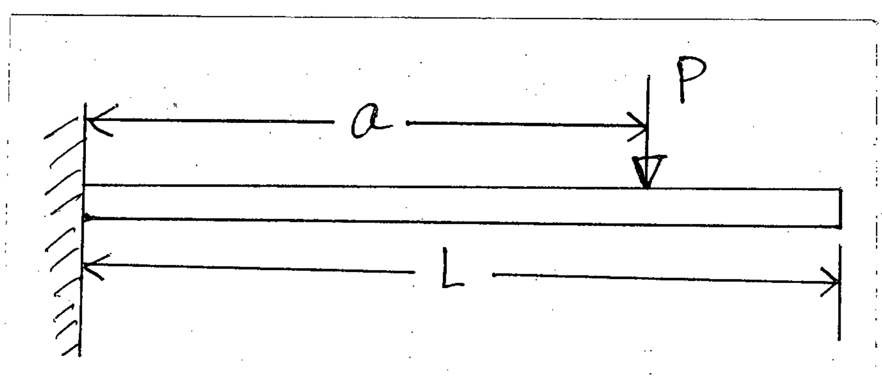


Fig. 6(a)

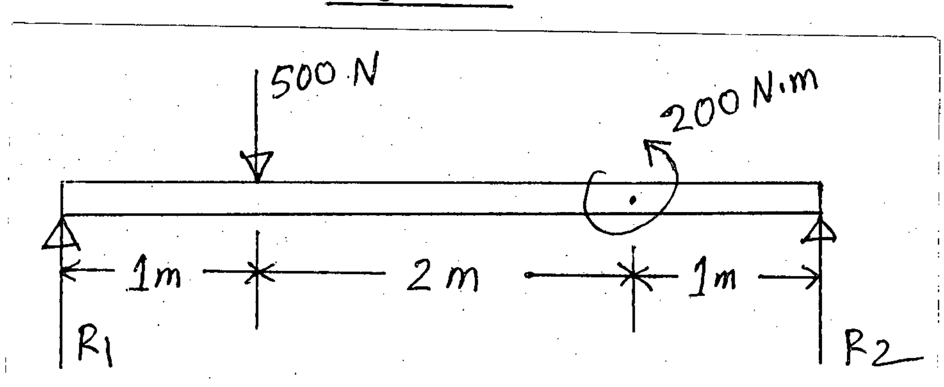


Fig. 6(b)

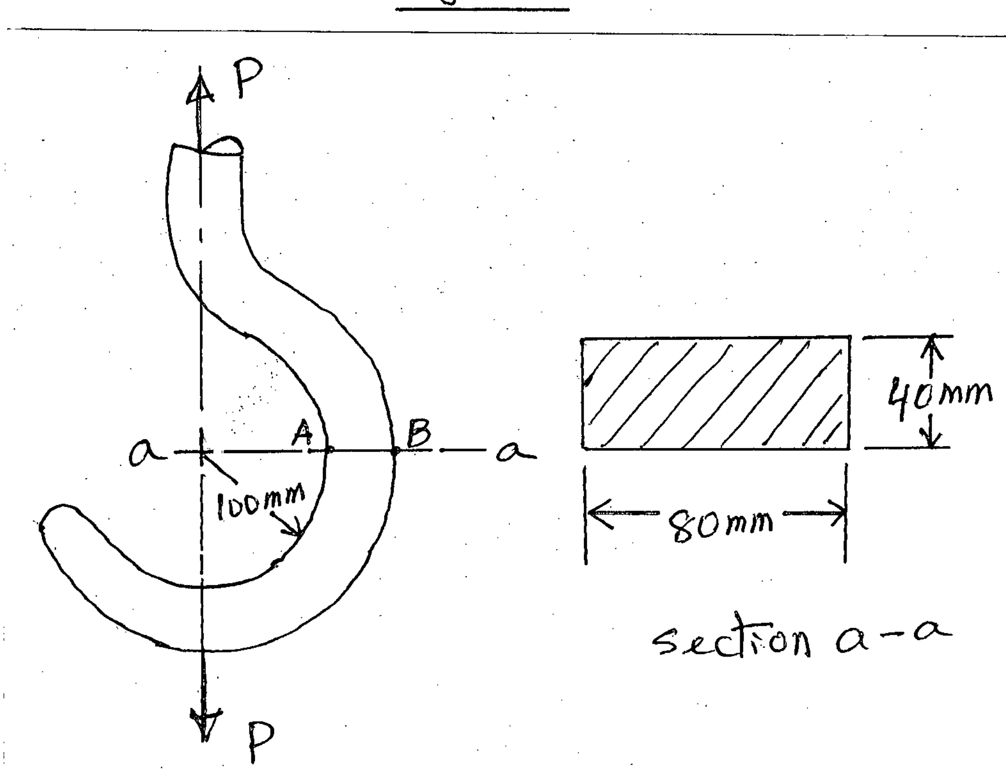


Fig. 7(a)

L-2/T-2/IPE **Date : 31/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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) Derive the expressions for the following compounding factors and mention one application for each corresponding interest formula. **(10)**
   (i) Sinking fund factor.
   (ii) Capital recovery factor.
   (iii) Gradient to present equivalent conversion factor.
   (iv) Gradient to uniform series conversion factor.

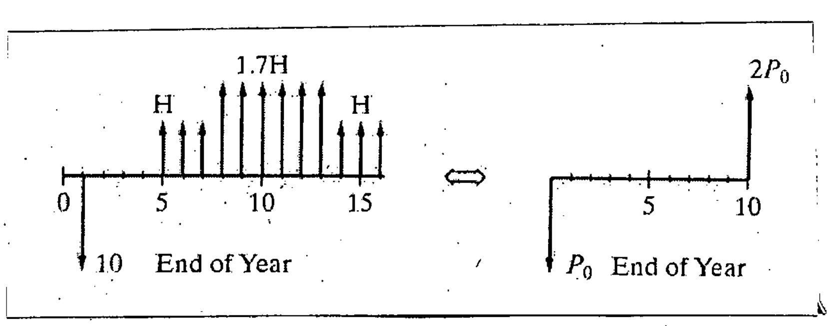
   (b) Qwest Airlines has implemented a program to recycle all plastic drink cup used on their aircraft. Their goal is to generate \$5 million by the end of the recycle program's five-year life. Each recycle cup can be sold for \$0.005 (1/2 cent). **(8)**
   (i) How many cups must be recycled annually to meet this goal? Assume uniform annual plastic cup usage and a 0% interest rate.
   (ii) Repeat Part (i) when the annual interest rate is 15%.
   (iii) Why is the answer to Part (ii) less than the answer to Part (i)?

   (c) Show that the following relationship is true: **($5\frac{1}{3}$)**

   $$(A/P, i\%, N) = i/[1-(P/F, i\%, N)]$$

2. (a) What is an investment balance diagram? Interpret the concept of IRR using an investment balance diagram. **(8)**

   (b) Determine the value of P_0, as a function of H, for these two investment alternatives to be equivalent at an interest rate of i = 15% per year. **($7\frac{1}{3}$)**



   (c) (i) What is the CW, when i = 10% per year, of \$1,500 per year, starting in year one and continuing forever; and \$10,000 in year five, repeating every four years thereafter, and continuing forever? **(8)**
   (ii) When i = 10% per year in this type of problem, what value of N, practically speaking, defines "forever"?

Contd P/2

IPE 209

3. (a) A company has the opportunity to take over a redevelopment project in an industrial area of a city. No immediate investment is required, but it must raze the existing buildings over a four-year period and, at the end of the fourth year, invest $2,400,000 for new construction. It will collect all revenues and pay all costs for a period of 10 years, at which time the entire project, and properties thereon, will revert to the city. The net cash flows are estimated to be as follows: **(13)**

Year End	Net Cash Flow
1	$500,000
2	300,000
3	100,000
4	–2,400,000
5	150,000
6	200,000
7	250,000
8	300,000
9	350,000
10	400,000

Tabulate the PW versus the interest rate and determine whether multiple IRRs exist. If so, use the ERR method when $\in = 8\%$ per year to determine a rate of return.

(b) A computer call center is going to replace all of its incandescent lamps with more energy-efficient fluorescent lighting fixtures. The total energy savings are estimated to be $1,875 per year, and the cost of purchasing and installing the fluorescent fixtures is $4,900. The study period is five years, and terminal market values for the fixtures are negligible. **($10\frac{1}{3}$)**

(i) What is the IRR of this investment?

(ii) What is the simple payback period of the investment?

(iii) Is there a conflict in the answers to Parts (i) and (ii)? List your assumptions.

(iv) The simple payback "rate of return" is $1/\theta$. How close does this metric come to matching your answer in Part (i)?

4. (a) Distinguish between *repeatability assumption* and *co-terminated assumption* with appropriate examples. **(4)**

(b) Briefly discuss *incremental investment analysis procedure.* **(6)**

(c) You have been asked to evaluate the economic implications of various methods for cooling condenser effluents from a 200-MW steam-electric plant. In this regard, cooling ponds and once-through cooling systems have been eliminated from consideration because of their adverse ecological effects. It has been decided to use cooling towers to dissipate waste heat to the atmosphere. There are two basic types of cooling towers: wet and dry.

Contd P/3

IPE 209

Contd ... Q. No. 4(c)

Furthermore, heat may be removed from condenser water (1) forcing (mechanically) air through the tower or (2) allowing heat transfer to occur by making use of natural draft. Consequently, there are four basic cooling tower designs that could be considered. Assuming that the cost of capital to the utility company is 12% per year, your job is to recommend the best alternative (i.e., the least expensive during the service life) in view of the data given the table below. Further, assume that each alternative is capable of satisfactorily removing waste heat from the condensers of a 200-MW power plant. What noneconomic factors can you identify that might also play a role in the decision-making process? **(13 $\frac{1}{3}$)**

Table: Alternative Types of Cooling Towers for a 200-Megawatt Fossil-Fired Power Plant Operating at Full Capacity[a]

	Alternative			
	Wet Tower Mech. Draft	Wet Tower Natural Draft	Dry Tower Mech. Draft	Dry Tower Natural Draft
Initial cost	\$3 million	\$8.7 million	\$5.1 million	\$9.0 million
Power for I.D. fans	40 200-hp induced-draft fans	None	20 200-hp I.D. fans	None
Power for pumps	20 150-hp pumps	20 150-hp pumps	40 100-hp pumps	40 100-hp pumps
Mechanical maintenance/year	\$0.15 million	\$0.10 million	\$0.17 million	\$0.12 million
Service life	30 years	30 years	30 years	30 years
Market value	0	0	0	0

[a] 100 hp = 74.6 kW; cost of power to plant is 2.2 cents per kWh or kilowatt-hour; induced-draft fans and pumps operate around the clock for 365 days/year (continuously). Assume that electric motors for pumps and fans are 90% efficient.

SECTION – B

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

5. (a) Write short note on "Classical Brainstorming". **(5)**

(b) Describe the outcomes that should be expected from a feasible alternative. What are the differences between potential alternative and feasible alternatives? **(8 $\frac{1}{3}$)**

(c) A small corporation is expecting an annual taxable income of \$45,000 for its tax year. It is considering an additional capital investment of \$100,000 in an engineering project, which is expected to create an added annual net cash flow (revenues minus expenses) of \$35,000 and an added annual depreciation deduction of \$20,000. What is the corporation's federal income tax liability (i) without the added capital investment and (ii) with the added capital investment? **(10)**

Table for Question no. 5(c)

TABLE 6-5 Corporate Federal Income Tax Rates

If taxable income is: Over	but not over	The tax is:	of the amount over
0	\$ 50,000	15%	0
\$ 50,000	75,000	\$ 7,500 + 25%	\$ 50,000
75,000	100,000	13,750 + 34%	75,000
100,000	335,000	22,250 + 39%	100,000
335,000	10,000,000	113,900 + 34%	335,000
10,000,000	15,000,000	3,400,000 + 35%	10,000,000
15,000,000	18,333,333	5,150,000 + 38%	15,000,000
18,333,333	....	6,416,667 + 35%	18,333,333

SOURCE: *Tax Information on Corporations*, IRS Publication 542, 1994.

Contd P/4

IPE 209

6. (a) ABC Corporation has a production (and sales) capacity of \$1,000,000 per month. Its fixed costs – over a considerable range of volume – are \$350,000 per month, and the variable costs are \$0.50 per dollar of sales. **(11 $\frac{1}{3}$)**

   (i) What is the annual breakdown point volume (D')? Develop (graph) the breakeven chart.

   (ii) What would be the effect on D' of decreasing the variable cost per unit by 25% if the fixed costs thereby increased by 10%?

   (iii) What would be the effect on D' if the fixed costs were decreased by 10% and the variable cost per unit increased by the same percentage?

   (b) Two alternative designs are under consideration for a tapered fastening pin. The fastening pins are sold for \$0.70 each. Either design will serve equally well and will involve the same material and manufacturing cost except for the lathe and drill operations. **(12)** Design A will require 16 hours of lathe time and 4.5 hours of frill time per 1,000 units. Design B will require 7 hours of lathe time and 12 hours of drill time per 1,000 units. The variable operating cost of the lathe, including labor, is \$18.60 per hour. The variable operating cost of the drill, including labor, is \$16.90 per hour. Finally, there is a sunk cost of \$5,000 for Design A and \$9,000 for Design B due to obsolete tooling?

   (i) Which design should be adopted if 95,000 units are sold each year?

   (ii) What is the annual saving over the other design?

7. (a) Write short note on Self-Liquidating Projects. **(6)**

   (b) What do you understand by Benefit/Cost ratio? Discuss the shortcomings of the Benefit/Cost ratio method. **(6 $\frac{1}{3}$)**

   (c) You have been assigned the task of comparing the economic results of three alternative designs for a state government public works project. The estimated values for various economic factors related to the three designs are as follows: **(11)**

Factor	Alternative Design		
	1	2	3
Capital investment	\$1,240,000	\$1,763,000	\$1,475,000
Salvage value (end of year 15)	90,000	150,000	120,000
Annual O & M Costs	215,000	204,000	201,000
Annual benefits to user group A	315,000	367,000	355,000
Annual benefits to other user groups	147,000	155,000	130,500

   The MARR being used is 9% and the analysis period is 15 years.

   (i) Use the conventional benefit/cost ratio method, with AW as the equivalent worth measure, to select the preferred design for the project.

   (ii) Use the modified B/C ratio method, with PW as the equivalent worth measure, to select preferred design for the project.

Contd P/5

IPE 209

8. (a) What are the purpose of using the results of cost estimation? Mention the two main tasks for cost-driven design optimization. **($6\frac{1}{3}$)**

(b) An asset for drilling was purchased and placed in service by a petroleum production company. Its cost basis is \$60,000 and it has an estimated market value (MV) of \$12,000 at the end of an estimated useful life of 14 years. Compute the depreciation amount in the third year and the book value (BV) at the end of the fifth year of life by each of the following methods: **(17)**

(i) The straight-line method

(ii) The SYD method

(iii) The 200% declining-balance method with switchover to straight-line.

= 6 =

(Table for Question No. 7(c))

Discrete Compounding, i = (9%)

TABLE C-12 Discrete Compounding: $i = 9\%$

N	Single Payment: Compound Amount Factor — To Find F Given P — F/P	Single Payment: Present Worth Factor — To Find P Given F — P/F	Uniform Series: Compound Amount Factor — To Find F Given A — F/A	Uniform Series: Present Worth Factor — To Find P Given A — P/A	Uniform Series: Sinking Fund Factor — To Find A Given F — A/F	Uniform Series: Capital Recovery Factor — To Find A Given P — A/P	Uniform Gradient: Gradient Present Worth Factor — To Find P Given G — P/G	Uniform Gradient: Gradient Uniform Series Factor — To Find A Given G — A/G	N
1	1.0900	0.9174	1.0000	0.9174	1.0000	1.0900	0.000	0.0000	1
2	1.1881	0.8417	2.0900	1.7591	0.4785	0.5685	0.842	0.4785	2
3	1.2950	0.7722	3.2781	2.5313	0.3051	0.3951	2.386	0.9426	3
4	1.4116	0.7084	4.5731	3.2397	0.2187	0.3087	4.511	1.3925	4
5	1.5386	0.6499	5.9847	3.8897	0.1671	0.2571	7.111	1.8282	5
6	1.6771	0.5963	7.5233	4.4859	0.1329	0.2229	10.092	2.2498	6
7	1.8280	0.5470	9.2004	5.0330	0.1087	0.1987	13.375	2.6574	7
8	1.9926	0.5019	11.0285	5.5348	0.0907	0.1807	16.888	3.0512	8
9	2.1719	0.4604	13.0210	5.9952	0.0768	0.1668	20.571	3.4312	9
10	2.3674	0.4224	15.1929	6.4177	0.0658	0.1558	24.373	3.7978	10
11	2.5804	0.3875	17.5603	6.8052	0.0569	0.1469	28.248	4.1510	11
12	2.8127	0.3555	20.1407	7.1607	0.0497	0.1397	32.159	4.4910	12
13	3.0658	0.3262	22.9534	7.4869	0.0436	0.1336	36.073	4.8182	13
14	3.3417	0.2992	26.0192	7.7862	0.0384	0.1284	39.963	5.1326	14
15	3.6425	0.2745	29.3609	8.0607	0.0341	0.1241	43.807	5.4346	15
16	3.9703	0.2519	33.0034	8.3126	0.0303	0.1203	47.585	5.7245	16
17	4.3276	0.2311	36.9737	8.5436	0.0270	0.1170	51.282	6.0024	17
18	4.7171	0.2120	41.3013	8.7556	0.0242	0.1142	54.886	6.2687	18
19	5.1417	0.1945	46.0185	8.9501	0.0217	0.1117	58.387	6.5236	19
20	5.6044	0.1784	51.1601	9.1285	0.0195	0.1095	61.777	6.7674	20
21	6.1088	0.1637	56.7645	9.2922	0.0176	0.1076	65.051	7.0006	21
22	6.6586	0.1502	62.8733	9.4424	0.0159	0.1059	68.205	7.2232	22
23	7.2579	0.1378	69.5319	9.5802	0.0144	0.1044	71.236	7.4357	23
24	7.9111	0.1264	76.7898	9.7066	0.0130	0.1030	74.143	7.6384	24
25	8.6231	0.1160	84.7009	9.8226	0.0118	0.1018	76.927	7.8316	25
30	13.2677	0.0754	136.3075	10.2737	0.0073	0.0973	89.028	8.6657	30
35	20.4140	0.0490	215.7108	10.5668	0.0046	0.0946	98.359	9.3083	35
40	31.4094	0.0318	337.8824	10.7574	0.0030	0.0930	105.376	9.7957	40
45	48.3273	0.0207	525.8587	10.8812	0.0019	0.0919	110.556	10.1603	45
50	74.3575	0.0134	815.0836	10.9617	0.0012	0.0912	114.325	10.4295	50
60	176.0313	0.0057	1944.7921	11.0480	0.0005	0.0905	118.968	10.7683	60
80	986.5517	0.0010	10950.5741	11.0998	0.0001	0.0901	122.431	11.0299	80
100	5529.0408	0.0002	61422.6755	11.1091	*	0.0900	123.234	11.0930	100
∞				11.1111		0.0900			∞

* Less than 0.0001.

L-2/T-2/IPE **Date : 06/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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) What is flat rolling? How Roll forces can be reduced in flat rolling? List the defects commonly observed after flat rolling. **(14)**

   (b) What are the similarities and differences between shielded metal are welding and submerged are welding process? **(12)**

   (c) Describe (with sketches) different types of Spot Welding Methods. **(9)**

2. (a) With the help of diagram, discuss the following: **(12)**

   (i) Close die forging

   (ii) Coining

   (iii) Upsetting

   (iv) Roll forging

   (b) What factors are involved in precision forging? Explain the various features of a typical forging die. **(11)**

   (c) Write the advantages, disadvantages and applications of 'Projection Welding'. **(12)**

3. (a) Explain the steps of friction welding with necessary schematic diagram. **(10)**

   (b) Describe the mechanism of laser beam welding and electron beam welding process with schematic diagram. **(13)**

   (c) Compare open die and closed die forging. How important is a close fit for two parts that are to be brazed? **(12)**

4. (a) What types of defect can develop on an extruded part? What are the significance of draw beads? **(12)**

   (b) What are the base material requirements for arc welding? Describe the difference between oxy-fuel gas cutting of ferrous and of non-ferrous alloys. **(12)**

   (c) Describe the main cause and remedies of inadequate joint penetration, slag inclusion and porosity in the weld joint. **(11)**

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IPE 205

SECTION – B

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

5. (a) Why is casting an important Manufacturing process? **(8)**

   (b) Explain in brief the causes and remedies of any three types of 'internal' casting defects. **(12)**

   (c) What is the difference between the solidification of pure metals and metal alloys? **(15)**

6. (a) Compare 'match plate pattern' with 'cope and drag pattern'. **(8)**

   (b) Explain the common allowances provided on patterns. **(12)**

   (c) Show three cases of casting part design where 'hot tears' and/or 'shrinkage cavities' can occur. Discuss design considerations for avoiding these defects with neat sketches. **(15)**

7. (a) Explain the effect of 'Grain shape' and 'moisture Content' on the 'green strength' of molding sand? **(8)**

   (b) State the differences between cold chamber die casting and hot chamber die casting. **(12)**

   (c) Describe the complete procedure of 'Shell Molding' with sketches. **(15)**

8. (a) Explain how microstructure of a part varies because of the method used for manufacturing. **(10)**

   (b) Briefly describe different forging defects. **(10)**

   (c) Differentiate closed die and flash-less forging process. What are the factors involved in precision forging? **(15)**
