L-3/T-2/IPE **Date : 18/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **IPE 303** (Product Design I)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) An arm is welded to a hollow shaft at section '1'. The hollow shaft is welded to a plate C at section '2'. The arrangement is shown in Fig 1(a) with dimensions. A force of P = 15 kN acts at arm A perpendicular to the axis of the arm. Calculate the size of weld at section '1' and '2'. The permissible shear stress in the weld is 120 MPa. **(15)**

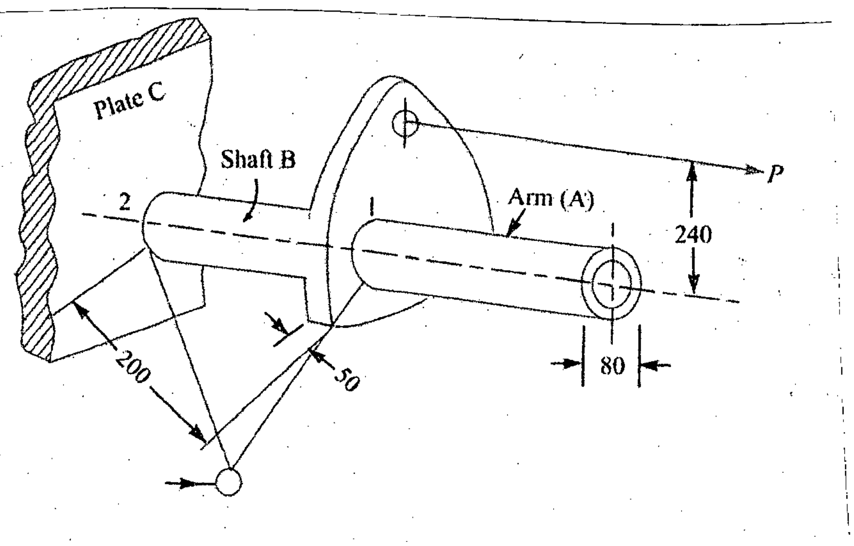

fig. 1 (a)

(b) A bracket in the form of a plate is fitted to a column by means of four rivets A, B, C and D in the same vertical line, as shown in Fig 1(b). AB = BC = CD = 60 mm. E is the mid-point of BC. A load of 100 kN is applied to the bracket at a point of F which is at horizontal distance of 150 m from E. The load acts at an angle of 30° to the horizontal. Determine the diameter of the rivets which are made of steel having a yield stress in shear of 240 MPa. Take a factor of safety of 1.5. What would be the thickness of the plate taking an allowable bending stress of 125 MPa for the plate, assuming its total width at section ABCD as 240 mm. **(20)**

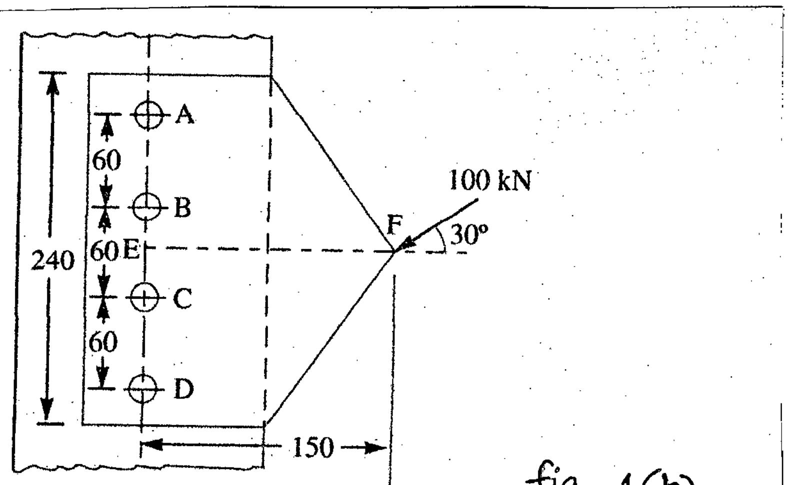

fig. 1(b)

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2. (a) A hollow shaft of 0.5 m outside diameter and 0.3 m inside diameter is used to drive a propeller of a marine vessel. The shaft is mounted on bearings 6 m apart and it transmits 5600 kW at 150 r.p.m. The maximum axial propeller thrust is 500 kN and shaft weights 70 kN. Determine **(8+5+4+4+5)**

   (i) The maximum shear stress developed in the shaft

   (ii) The lateral deflection using Castigliano's theorem.

   (iii) The angular twist between the bearings.

   (iv) What would be its first critical speed? Assume, Young's modulus 180 GPa and density 1000 kg/m^3.

   (v) Including all of the above considerations in constraints, formulate an optimization problem so that cost of manufacturing the shaft will be minimized.

   (b) The hydraulic cylinder 400 mm bore operated at a maximum pressure of 5 N/mm^2 as shown in Fig. 2 (b). The piston rod is connected to the load and the cylinder to the frame through hinged joints. Design: Cylinder, Piston rod and Hinge pin. **(9)**

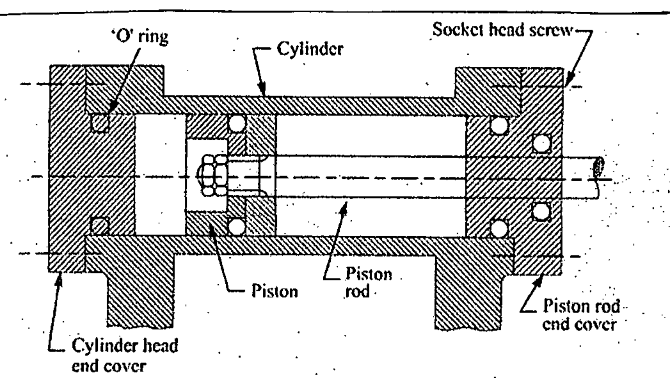

fig. 2 (b)

3. (a) A pulley is keyed to a shaft midway between two bearings. The shaft is made of cold drawn steel for which the ultimate strength is 550 MPa and the yield strength is 400 MPa. The bending moment at the pulley varies from -150 N-m to +400 N-m as the torque on the shaft varies from -50 N-m to +150 N-m. Determine the diameter of the shaft for a life of at least 10^7 cycles using distortion energy theorem. The stress concentration factors for the keyway at the pulley in bending and in torsion are 1.6 and 1.3 respectively. **(17)**

   Take the following values:

   Factor of safety = 1.5

   Load correction factors = 1.0 in normal loading and 0.6 in shear loading

   Size effect factor = 0.85

   Surface effect factor = 0.88

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Contd... Q. No. 3

(b) A toggle jack as shown in Fig.3(b), is to be designed for lifting a load of 4 kN. When the jack is in the top position, the distance between the center lines of nuts is 50 mm and, in the bottom position this distance is 210 mm. the eight links of the jack are symmetrical and 110 mm long. The link pins in the base are set 30 mm apart. The links, screw and pins are made from mild steel for which the permissible stresses are 100 MPa in tension and 50 MPa in shear. The bearing pressure of the pins is limited to 20 N/mm^2. Assume the pitch of the square threads as 6 mm and the coefficient of friction between threads as 0.20. **(18)**

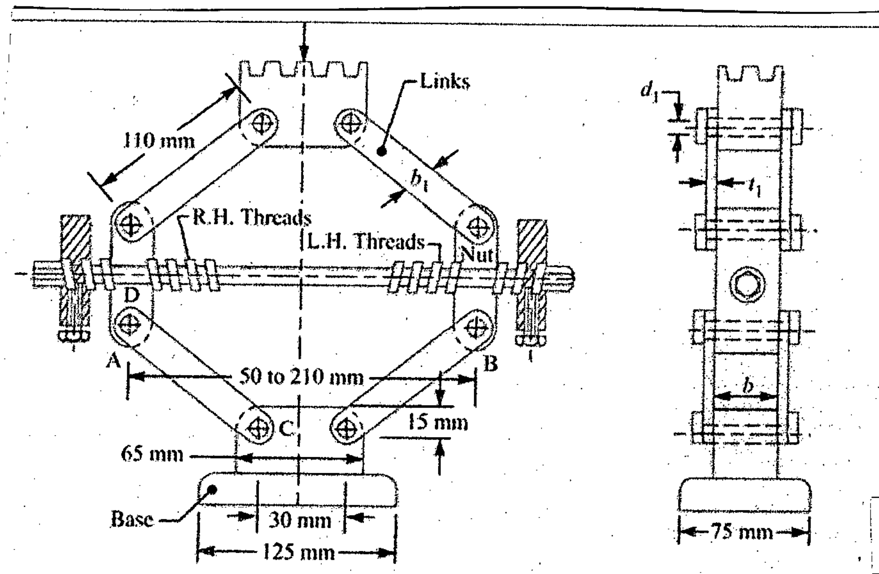

fig. 3 (b)

4. (a) The constructional details of an exhaust valve of a diesel engine are shown in Fig. 4(a). The diameter of the valve is 32 mm and the suction pressure in the cylinder is 0.03 N/mm^2. The mass of the valve is 50 gm. The maximum valve lift is 10 mm. The stiffness of the spring for the valve is 10 N/mm. The spring index can be assumed as 8. **(4+2+12)**

   (i) What is the function of rocker arm and push rod?

   (ii) What type of spring actually used?

   (iii) Neglecting the effect of inertia forces, design the spring for static consideration and determine the factor of safety for fatigue loading after defining the actual reason for fatigue loading considerations.

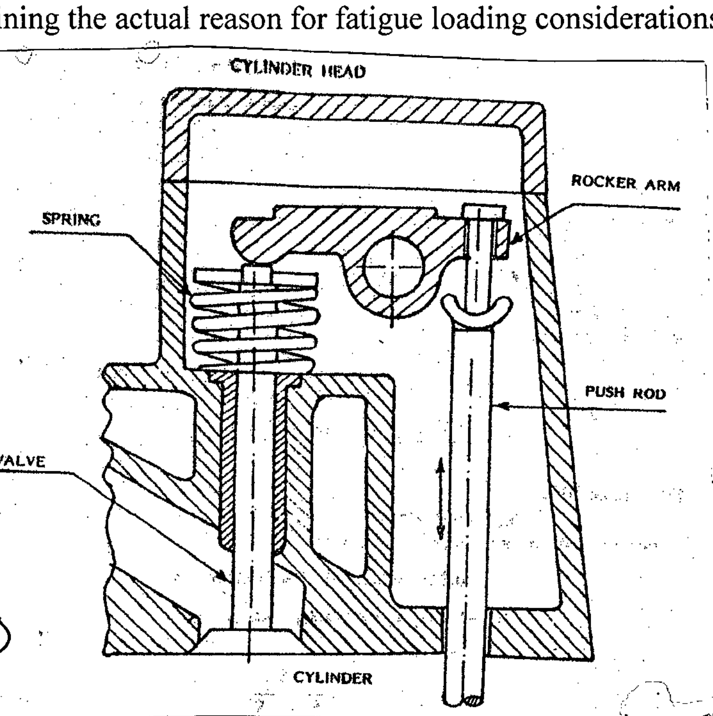

fig. 4 (a)

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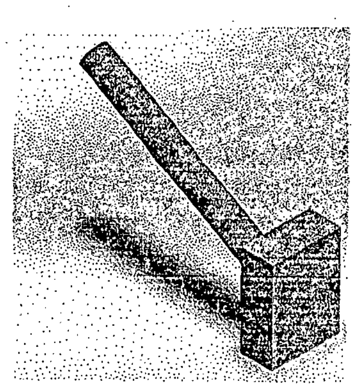
Contd... Q. No. 4(a)

Consider, oil-hardened and tempered spring steel wire is used and relationship between wire diameter and minimum tensile strength can be perceived from following data.

Wire diameter d (mm)	Minimum tensile strength N/mm^2	
	SW	VW
2.0	1620	1520
2.5	1570	1470
3.0	1520	1430
3.6	1480	1400
4	1480	1400

(b) A cantilever beam is supported as shown in Fig 4(b) to be used for a particular purpose. Suppose, the beam is immersed on the river and the river water is flowing at different velocity at different layer from the bottom. Suppose that, the force distribution from bottom to top of the river, follows a triangular distribution with peak value 500 N. The attacking force on the initial point of the beam, where the beam is attached to the vertical support is 50 N. Suddenly, a garbage of 80 kg falls on the outer most extreme point vertically. Design the diameter of the beam if the projection of the beam on the river is $10\sqrt{2}$ m and inclined at 45 degrees with the river bed. Consider, the beam is made of steel 45C8 with a tensile yield strength of 380 N/mm^2. The factor safety is 2.5. **(12)**

fig. 4(b)



(c) What do you mean by critical frequency of helical spring? Derive mathematical equation for it. **(5)**

SECTION-B

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

5. (a) You are responsible for arranging a design team for the development of a new brand of food product for your company. Mention any six individuals whom you should incorporate in your team, and elaborate their roles. **(05)**

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Contd... Q. No. 5

(b) Discuss the 'Specification Development' phase of the product design process for a company who are planning to launch a new model of family sedan car. **(10)**

(c) Explain Function, Sub-function and Constraint, using digital SLR camera as an example. **(10)**

(d) Briefly describe the working mechanism and design consideration of diaphragm spring of a single plate dry clutch with necessary schematic diagrams. **(10)**

6. (a) The basic QFD methodology involves four basic phases – Explain each phases with appropriate example. **(10)**

(b) Justify the four purposes of prototype to a multinational company who are designing a new version of smart phone. **(10)**

(c) Formulate torque transmission capacity equation of semi-centrifugal clutch with necessary schematic diagrams. **(10)**

(d) Write a short note on "Design for Manufacturing". **(05)**

7. (a) What are the steps to identify customer needs? Explain each step with example. **(05)**

(b) Explain the 'FAST method' for functional decomposition. **(10)**

(c) Compare the traditional and concurrent engineering approaches of product development. **(10)**

(d) i) A 15 kW, 960 r.p.m. motor has a mild steel of 40 mm diameter and the extension being 75 mm. The permissible shear and crushing stresses for mild steel key are 56 MPa and 112 MPa respectively. Design the keyway in the motor shaft extension. Check the shear strength of the key against normal strength of the shaft. **(7+3)**

(ii) Differentiate between Gib-head taper key and woodruff key with necessary diagrams. Also mention their application differences.

8. (a) Write a short note on 'Function Analysis System Technique'. **(9)**

(b) For a ready-made garments factory, discuss the possible advantages of implementing ISO 14000 EMS. **(10)**

(c) What are the steps for subtract and operate procedure? Draw a function tree for a blender using subtract and operate procedure and explain. **(10)**

(d) Draw the following components and write down the purpose of using them. **(2×3=6)**

(i) Multi-Leaf spring

(ii) Setscrews

(iii) Retaining ring

L-3/T-2/IPE **Date : 24/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **IPE 319** (Quality Management)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) In the new version of ISO9000:2015, some changes are explicit. What are the explicit changes with respect to "Product", "risk" "six compulsory procedures" and "document and Records"? **(15)**

   (b) What will be the defect rate in case of 3σ limit and process control with 1.5σ shift in process mean? Compute defect rate using appropriate and comprehensive diagram. **(20)**

2. (a) Which "S", in 5S philosophy, is the most difficult to implement and achieve? Explain this "S". **(15)**

   (b) What are the three kinds of losses which may take place as per Taguchi Loss Function? Explain with necessary diagrams (if any). **(20)**

3. (a) According to Juran, 100% good quality level may not be of interest to the company in terms of cost. If this is true, then zero defect concept is not economically beneficial. Do you agree? Justify with schematic diagrams. **(15)**

   (b) What are the four phases (or stages or steps) in the complete Quality Function Development (QFD) methodology? Explain with appropriate diagram. **(20)**

4. (a) What is Risk Priority Number in FMEA analysis? Define and explain. **(15)**

   (b) For the following combinatorial matrix, fill in the ANOVA table (attached in the question paper) and find Red X and Pink X factors. Afterwards, attach the filled in ANOVA table to Section-A of your answer script. **(20)**

Factors A and B

Factors C and D		A– B–	A– B+	A+ B–	A+ B+
C–	D–	1 (– – – –) 22 20	3 (– + – –) 20 16	7 (+ – – –) 10 12	12 (+ + – –) 115 117
C–	D+	8 (– – – +) 18 22	10 (– + – +) 32 34	4 (+ – – +) 16 14	13 (+ + – +) 13 13
C+	D–	6 (– – + –) 11 15	2 (– + + –) 24 26	11 (+ – + –) 42 44	15 (+ + + –) 13 15
C+	D+	14 (– – + +) 40 44	16 (– + + +) 15 21	5 (+ – + +) 16 16	9 (+ + + +) 12 10

SECTION-B

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

5. (a) List and explain at least five advantages of control charts. **(05)**

(b) Discuss the Phase I and Phase II of control chart application. **(10)**

(c) What are the types of variable charts? When $\bar{x} - S$ chart should be used rather than $\bar{x} - R$ chart? **(10)**

(d) A control chart indicates that the current process fraction nonconforming is 0.02. If 50 items are inspected each day, what is the probability of detecting a shift in the fraction nonconforming to 0.04 on the first day after the shift and by the end of the third day following the shift? **(10)**

6. (a) Discuss the operating-characteristic function of $\bar{x}$ and R chart. Define 'Average Run Length' and 'Average Time to Signal' for the $\bar{x}$ Chart. **(10)**

(b) Explain the performance advantages of CUSUM and Weighted average charts relative to Shewhart control chart. **(10)**

(c) A normally distributed quality characteristic is controlled by $\bar{x}$ and R charts having the following parameters (n=4, both charts are in control): **(10)**

R Chart	**$\bar{x}$ Chart**
UCL = 18.795	UCL = 626
Center line = 8.236	Center line = 620
LCL = 0	LCL = 614

(i) What is the estimated standard deviation of the quality characteristic x?

(ii) If specifications are 610 ±15, what is your estimate of the fraction of non-conforming material produced by this process when it is in control at the given level?

(iii) Suppose you wish to establish a modified chart to substitute for the original chart. The process mean is to be controlled so that the fraction nonconforming is less than 0.005. The probability of type I error is to be 0.01. What control limits do you recommend?

(d) Suppose that a stable process has upper and lower specifications at USL = 62 and LSL = 38. A sample of size n = 20 from this process reveals that the process mean is centered approximately at the midpoint of the specification interval and that the sample standard deviation $s = 1.75$. Find a 95% confidence interval on Cp. **(05)**

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Contd... Q. No.7

7. (a) Discuss the Markov Chain Approach to Finding the ARLs for CUSUM and EWMA Control Charts. **(10)**

(b) Explain the gauge and measurement system capability studies. **(10)**

(c) The tensile strength and diameter of a textile fiber are two important quality characteristics that are to be jointly controlled. The quality engineer has decided to use n = 10 fiber specimens in each sample. He has taken 20 preliminary samples, and on the basis of these data he concludes that $\overline{\overline{x}}_1 = 115.59$ psi, $\overline{\overline{x}}_2 = 1.06(\times 10^{-2})$ inch, $\overline{s_1^2} = 1.23$, $\overline{s_2^2} = 0.83$ and $\overline{s_{12}} = 0.79$. Write down the statistic of a T^2 control chart that can be used for process control purpose. Calculate the UCL if $\alpha = 0.001$. (Use $F_{0.001,2,179} = 7.18$). **(05)**

(d) Define C_p, C_{pk} and k. Mention the relationship equation among these indices. **(10)**

8. (a) Write a short note on DMAIC model for improvement. **(10)**

(b) Explain the Multivariate EWMA control chart. **(10)**

(c) What are the major aspects of lean manufacturing? **(15)**

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Cumulative Poisson Distribution Table

Table shows cumulative probability functions of Poisson Distribution with various α. Example: to find the probability $P(X \leq 3)$ where X has a Poisson Distribution with $\alpha = 2$, look in row 4 and column 4 to find $P(X \leq 3)$=0.8571 where X is Poisson(2).

	α									
x	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
0	0.6065	0.3679	0.2231	0.1353	0.0821	0.0498	0.0302	0.0183	0.0111	0.0067
1	0.9098	0.7358	0.5578	0.4060	0.2873	0.1991	0.1359	0.0916	0.0611	0.0404
2	0.9856	0.9197	0.8088	0.6767	0.5438	0.4232	0.3208	0.2381	0.1736	0.1247
3	0.9982	0.9810	0.9344	0.8571	0.7576	0.6472	0.5366	0.4335	0.3423	0.2650
4	0.9998	0.9963	0.9814	0.9473	0.8912	0.8153	0.7254	0.6288	0.5321	0.4405
5	1.0000	0.9994	0.9955	0.9834	0.9580	0.9161	0.8576	0.7851	0.7029	0.6160
6	1.0000	0.9999	0.9991	0.9955	0.9858	0.9665	0.9347	0.8893	0.8311	0.7622
7	1.0000	1.0000	0.9998	0.9989	0.9958	0.9881	0.9733	0.9489	0.9134	0.8666
8	1.0000	1.0000	1.0000	0.9998	0.9989	0.9962	0.9901	0.9786	0.9597	0.9319
9	1.0000	1.0000	1.0000	1.0000	0.9997	0.9989	0.9967	0.9919	0.9829	0.9682
10	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9990	0.9972	0.9933	0.9863
11	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9991	0.9976	0.9945
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9992	0.9980
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9997	0.9993
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999	0.9998
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9999
16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

For Question 4b: Fill in the following ANOVA table and attach it to Section-A of answer script

Cell group	Factors				2 factors interactions						3 factors interactions				4 factors interactions	Output
	A	B	C	D	AB	AC	BC	AD	BD	CD	ABC	ABD	ACD	BCD	ABCD	
1	–	–	–	–	+	+	+	+	+	+	–	–	–	–	+	
2	+	–	–	–	–	–	+	–	+	+	+	+	+	–	–	
3	–	+	–	–	–	+	–	+	–	+	+	+	–	+	–	
4	+	+	–	–	+	–	–	–	–	+	–	–	+	+	+	
5	–	–	+	–	+	–	–	+	+	–	+	–	+	+	–	
6	+	–	+	–	–	+	–	–	+	–	–	+	–	+	+	
7	–	+	+	–	–	–	+	+	–	–	–	+	+	–	+	
8	+	+	+	–	+	+	+	–	–	–	+	–	–	–	–	
9	–	–	–	+	+	+	+	–	–	–	–	+	+	+	–	
10	+	–	–	+	–	–	+	+	–	–	+	–	–	+	+	
11	–	+	–	+	–	+	–	–	+	–	+	–	+	–	+	
12	+	+	–	+	+	–	–	+	+	–	–	+	–	–	–	
13	–	–	+	+	+	–	–	–	–	+	+	+	–	–	+	
14	+	–	+	+	–	+	–	+	–	+	–	–	+	–	–	
15	–	+	+	+	–	–	+	–	+	+	–	–	–	+	–	
16	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Main and interaction contribution	49	67	–65		71	–77	–159		–103	77	–115		61	79	183	

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Table B. Factors used in 3σ Quality Control Charts.

Sample size n	$\overline{X}$ charts: Factors for control limits			S charts: Factors for central line	S charts: Factors for control limits				R charts: Factors for central line	R charts: Factors for control limits				
	A	A_2	A_3	c_4	B_3	B_4	B_5	B_6	d_2	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	0	3.267	0	2.606	1.128	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	0	2.568	0	2.276	1.693	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	0	2.266	0	2.088	2.059	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	0	2.089	0	1.964	2.326	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	0.030	1.970	0.029	1.874	2.534	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	0.118	1.882	0.113	1.806	2.704	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	0.185	1.815	0.179	1.751	2.847	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	0.239	1.761	0.232	1.707	2.970	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	0.284	1.716	0.276	1.669	3.078	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	0.321	1.679	0.313	1.637	3.173	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	0.354	1.646	0.346	1.610	3.258	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	0.382	1.618	0.374	1.585	3.336	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	0.406	1.594	0.399	1.563	3.407	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	0.428	1.572	0.421	1.544	3.472	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	0.448	1.552	0.440	1.526	3.532	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	0.466	1.534	0.458	1.511	3.588	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	0.482	1.518	0.475	1.496	3.640	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	0.497	1.503	0.490	1.483	3.689	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	0.510	1.490	0.504	1.470	3.735	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	0.523	1.477	0.516	1.459	3.778	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	0.534	1.466	0.528	1.448	3.819	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	0.545	1.455	0.539	1.438	3.858	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	0.555	1.445	0.549	1.429	3.895	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	0.565	1.435	0.559	1.420	3.931	0.708	1.806	6.056	0.459	1.541

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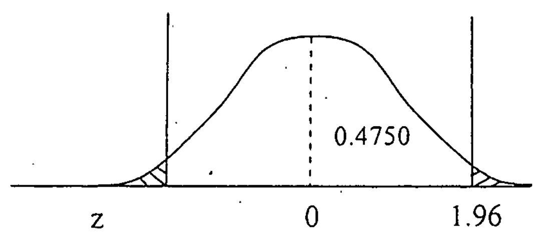
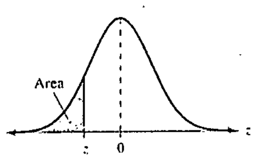
Table A. Standard Normal Distribution Values (Areas under the normal curve).



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

IPE 319 =8=

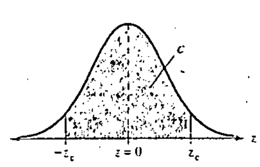
Table 4—Standard Normal Distribution



z	.09	.08	.07	.06	.05	.04	.03	.02	.01	.00
−3.4	.0002	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003
−3.3	.0003	.0004	.0004	.0004	.0004	.0004	.0004	.0005	.0005	.0005
−3.2	.0005	.0005	.0005	.0006	.0006	.0006	.0006	.0006	.0007	.0007
−3.1	.0007	.0007	.0008	.0008	.0008	.0008	.0009	.0009	.0009	.0010
−3.0	.0010	.0010	.0011	.0011	.0011	.0012	.0012	.0013	.0013	.0013
−2.9	.0014	.0014	.0015	.0015	.0016	.0016	.0017	.0017	.0018	.0019
−2.8	.0019	.0020	.0021	.0021	.0022	.0023	.0023	.0024	.0025	.0026
−2.7	.0026	.0027	.0028	.0029	.0030	.0031	.0032	.0033	.0034	.0035
−2.6	.0036	.0037	.0038	.0039	.0040	.0041	.0043	.0044	.0045	.0047
−2.5	.0048	.0049	.0051	.0052	.0054	.0055	.0057	.0059	.0060	.0062
−2.4	.0064	.0066	.0068	.0069	.0071	.0073	.0075	.0078	.0080	.0082
−2.3	.0084	.0087	.0089	.0091	.0094	.0096	.0099	.0102	.0104	.0107
−2.2	.0110	.0113	.0116	.0119	.0122	.0125	.0129	.0132	.0136	.0139
−2.1	.0143	.0146	.0150	.0154	.0158	.0162	.0166	.0170	.0174	.0179
−2.0	.0183	.0188	.0192	.0197	.0202	.0207	.0212	.0217	.0222	.0228
−1.9	.0233	.0239	.0244	.0250	.0256	.0262	.0268	.0274	.0281	.0287
−1.8	.0294	.0301	.0307	.0314	.0322	.0329	.0336	.0344	.0352	.0359
−1.7	.0367	.0375	.0384	.0392	.0401	.0409	.0418	.0427	.0436	.0446
−1.6	.0455	.0465	.0475	.0485	.0495	.0505	.0516	.0526	.0537	.0548
−1.5	.0559	.0571	.0582	.0594	.0606	.0618	.0630	.0643	.0655	.0668
−1.4	.0681	.0694	.0708	.0722	.0735	.0749	.0764	.0778	.0793	.0808
−1.3	.0823	.0838	.0853	.0869	.0885	.0901	.0918	.0934	.0951	.0968
−1.2	.0985	.1003	.1020	.1038	.1056	.1075	.1093	.1112	.1131	.1151
−1.1	.1170	.1190	.1210	.1230	.1251	.1271	.1292	.1314	.1335	.1357
−1.0	.1379	.1401	.1423	.1446	.1469	.1492	.1515	.1539	.1562	.1587
−0.9	.1611	.1635	.1660	.1685	.1711	.1736	.1762	.1788	.1814	.1841
−0.8	.1867	.1894	.1922	.1949	.1977	.2005	.2033	.2061	.2090	.2119
−0.7	.2148	.2177	.2206	.2236	.2266	.2296	.2327	.2358	.2389	.2420
−0.6	.2451	.2483	.2514	.2546	.2578	.2611	.2643	.2676	.2709	.2743
−0.5	.2776	.2810	.2843	.2877	.2912	.2946	.2981	.3015	.3050	.3085
−0.4	.3121	.3156	.3192	.3228	.3264	.3300	.3336	.3372	.3409	.3446
−0.3	.3483	.3520	.3557	.3594	.3632	.3669	.3707	.3745	.3783	.3821
−0.2	.3859	.3897	.3936	.3974	.4013	.4052	.4090	.4129	.4168	.4207
−0.1	.4247	.4286	.4325	.4364	.4404	.4443	.4483	.4522	.4562	.4602
−0.0	.4641	.4681	.4721	.4761	.4801	.4840	.4880	.4920	.4960	.5000

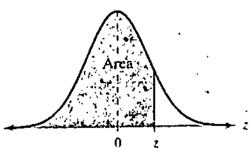
Critical Values

Level of Confidence c	z_c
0.80	1.28
0.90	1.645
0.95	1.96
0.99	2.575



IPE 319 = 9 =

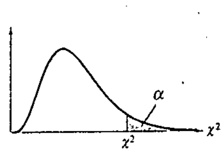
Table 4—Standard Normal Distribution *(continued)*



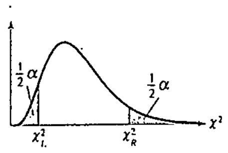
z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9278	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

IPE 319 = 10 =

Table 6— Chi-Square Distribution



Right tail



Two tails

Degrees of freedom	α									
	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.299
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289	42.796
23	9.262	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

L-3/T-2/IPE **Date : 28/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **IPE 315** (Operations Management)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

Assume any missing data.

1. (a) Time study and Standard element time are two different techniques to calculate standard time. Which one of these two techniques is more accurate and why? **(5)**

(b) How can you distinguish Pull system from Push system? Provide example for both types of system with respect to sector in Bangladesh. **(7)**

(c) Aggregate planning is often termed as "Rolling planning horizon" – why? **(6)**

(d) Do you think that all the raw materials in the warehouse are kept in the same way? If not, what are the principles to be followed to store raw materials? Explain. **(8)**

(e) For the following table of produced components in an hour time, calculate standard time with a performance rating of 1.25 using an allowance of 12% of normal time: **(9)**

Worker	A	B	C	D	E	F	G	H
no of parts	15	18	14	17	16	13	18	16

2. (a) How can you distinguish back order in demand option from inventory in capacity option for aggregate planning? Provide examples for both. **(6)**

(b) New and matured products are alternative to each other – why? **(5)**

(c) EOQ may or may not pass through the intersection point of holding cost and ordering cost – how? **(6)**

(d) Briefly describe the working principle of "Kanbam" system in a fast food chain. **(8)**

(e) For the following order table, decide the sequence of jobs to be processed based on Johnson's Rule. Also show the jobs' duration in a time frame. **(10)**

Processing Time (days)

Job	Station 1	Station 2	Station 3
A	7	2	3
B	6	4	2
C	8	5	4
D	9	2	5
E	10	3	7

Contd P/2

IPE 315

3. (a) Briefly describe three different factors in determining capacity alternatives with examples. **(12)**

(b) Master production schedule (MPS) is opposite to Aggregate Planning – Justify. **(8)**

(c) Based on the following data, select the best machine to purchase without permitting any loss and meeting custom demand: **(15)**

Demand = 1500 ~ 2500 units

Revenue = 187 BDT/unit   Variable cost = 170 BDT/unit

Machine	Fixed Cost (BDT)	Capacity (units)
A	16,000	1,000
B	30,000	2,000
C	42,000	3,000

Which steps should you take if none of the machines found suitable to be purchased?

4. (a) How can you distinguish efficiency from productivity? **(5)**

(b) Work measurement is a vital input for budgeting and scheduling – how? **(6)**

(c) Long term and short term capacity requirements can be related to two different forecasting patterns. Discuss both with appropriate example. **(5)**

(d) Calculate EOQ for the following data: **(9)**

Annual demand	=	800 units
Ordering cost	=	$ 9/order
Holding cost	=	$ 3/unit/year
Cost per unit	=	$ 18 for lot size 1 ~ 49
		$ 17.75 for lot size 50 ~ 99
		$ 17.5 for lot size 100 ~ 149
		$ 17.25 for lot size 150 ~ 199
		$ 17 for lot size 200 ~ up

(e) For the following order table, select the best sequence of jobs to be processed based on SPT and EDD rules with logic behind your selection: **(10)**

Job	processing Time (days)	Due date (days)
A	3	4
B	5	7
C	4	8
D	6	9
E	2	5

IPE 315

SECTION-B

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

5. (a) A computer software firm has experienced the following demand for its "Personal Finance" software package. **(11)**

Months	**Unit**
September, 2017	56
October, 2017	61
November, 2017	55
December, 2017	70
January, 2018	66

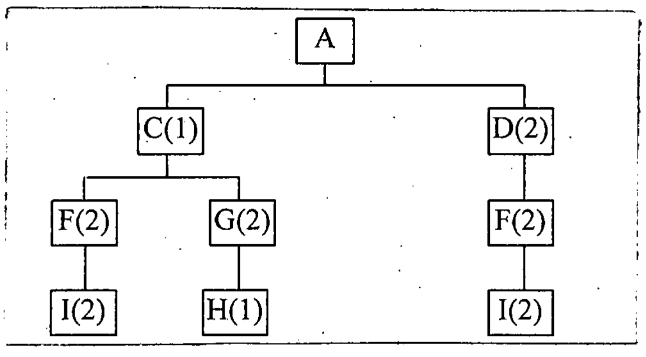
Develop a regression analysis to forecast the demand and find the forecast for the month of January 2019.

(b) Actual demand of a product of certain company has been given for four quarters and forecasts have been estimated by 4 different methods (method1, method2, method3, method4). Using MAD, find the appropriate method of forecasting among the following 4 methods. **(12)**

Quarter	Actual Demand	Method1	Method2	Method3	Method4
1	105	100	110	120	100
2	150	120	140	140	140
3	93	125	130	125	110
4	100	110	120	120	99

(c) Discuss different issues in facility location in detail. **(12)**

6. Brown and Brown Electronics manufacture a line of digital audiotape (DAT) players. The bill of materials, showing the number of each item required is shown below: **(35)**



Data for A: Gross requirements is 100 units on 9th week, Lead time is 2 weeks, Lot for lot

Data for C: Lead time is 1 week, Lot for lot

Data for D: Lead time is 2 weeks, schedule receipt is 30 on 1st week, lot size 170 units

Data for F: Lead time is 1 week, schedule receipt is 60 on 1st week, on hand inventory is 15, lot for lot

Data for G: Lead time is 1 week, schedule receipt is 100 on 1st week, on hand inventory is 50, lot for lot

Data for H: Lead time is 1 week, schedule receipt is 50 on 1st week, lot size 200

Data for I: Lead time is 1 week, schedule receipt is 60 on 1st week, on hand inventory is 15, lot for lot

Prepare a MRP schedule to satisfy demand.

Contd P/4

IPE 315

7. (a) For the machine-part matrix shown below, form cells using Direct Clustering Algorithm (DCA) and, if conflicts exist, propose alternative approaches for resolving the conflicts. **(15)**

	Machine #				
Part #	1	2	3	4	5
1	1		1		
2	1				
3		1		1	1
4	1		1		
5		1			
6				1	1

(b) Briefly describe the different types Facility layout with their relative advantages. **(20)**

8. (a) What is the basic concept of aggregation in planning? What is the main scope of Aggregate Planning? **(6)**

(b) How can a robust capacity plan affect the life of a manager? What is the consequence of poor capacity plan planning? **(7)**

(c) Complete the following two production plans, calculate total cost for each plan and select the best plan out of the two with justification. **(22)**

Month	Jan	Feb	Mar	Apr	May	Jun	Total
Beginning inventory	350						
Demand Forecast	1500	1300	900	900	1000	1400	
Safety Stock (0.25 × Demand							
Production Requirement							
Working days per month	22	19	21	21	22	20	
Ending Inventory							

Plan 1: Exact Production - Varying workforce

Month	Jan	Feb	Mar	Apr	May	Jun	Total
Production Requirement							
Total time required (5hrs/unit)							
Working days per month							
Available hrs/month/worker (8hrs/day)							
Workers required							
New workers hired							
Hiring cost ($200/worker)							
Workers laid off							
Layoff cost ($250/worker)							
Straight time cost ($4/hr)							
Total Cost							

Plan 2: Constant workforce - Varying inventory & Stockout

Month	Jan	Feb	Mar	Apr	May	Jun	Total
Beginning Inventory							
Working days per month							
Available hrs per month (8hrs/day)							
Actual Production (5hrs/unit)							
Demand Forecast							
Ending Inventory							
Shortage cost ($5/unit)							
Safety stock							
Unit excess							
Inventory cost ($1.5/unit)							
Straight time cost ($4/hr)							
Total Cost							

L-3/T-2/IPE **Date : 06/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **IPE 329** (Numerical Analysis)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Two distances are required to specify the location of a point relative to an origin in two-dimensional space (Fig. 1*a*): **(10)**

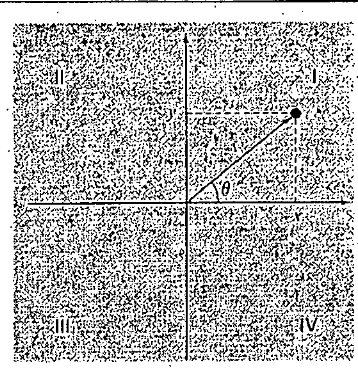


Fig. 1*a*

(i) The horizontal and vertical distances (x,y) in Cartesian coordinates

(ii) The radius and angle (r, θ) in radial coordinates.

It is relatively straightforward to compute Cartesian coordinates (x,y) on the basis of polar coordinates (r, θ). The reverse process is not so simple. The radius can be computed by the following formula:

$$r = \sqrt{(x^2 + y^2)}$$

If the coordinates lie within the first and forth coordinates (i.e., $x > 0$), then a simple formula can be used to compute θ.

$$\theta = \tan^{-1}\left(\frac{y}{x}\right)$$

The difficulty arises for the other cases. The following table summarizes the possibilities:

x	y	θ
<0	>0	$\tan^{-1}(y/x) + \pi$
<0	<0	$\tan^{-1}(y/x) - \pi$
<0	=0	π
=0	>0	$\pi/2$
=0	<0	$-\pi/2$
=0	=0	0

Write a well-structured flowchart for a subroutine procedure to calculate r and θ as a function of x and y. Express the final results for θ in degrees.

Contd P/2

(b) In solving the free-falling bungee jumper problem, we generally assume that the acceleration due to gravity is a constant value of 9.81 m/s^2. Although this is a decent approximation when we are examining falling objects near the surface of the earth, the gravitational force decreases as we move above sea level. A more general representation based on Newton's inverse square law of gravitational attraction can be written as **(17)**

$$g(x) = g(0)\frac{R^2}{(R+x)^2}$$

where $g(x)$ = gravitational acceleration at altitude x (in m) measured upward from the earth's surface (m/s^2), $g(0)$ = gravitational acceleration at the earth's surface ($\cong$ 9.81 m/s^2), and R = the earth's radius ($\cong 6.37 \times 10^6$ m).

(i) Use a force balance to derive a differential equation for velocity as a function of time that utilizes this more complete representation of gravitation. However, for this derivation, assume that upward velocity is positive.

(ii) For the case where drag is negligible, use the chain rule to express the differential equation as a function of altitude rather than time. Recall that the chain rule is

$$\frac{d\upsilon}{dt} = \frac{d\upsilon}{dx}\frac{dx}{dt}$$

(iii) Use calculus to obtain the closed form solution where $v = v_0$ at $x = 0$.

(iv) Use Euler's method to obtain a numerical solution from $x = 0$ to 50,000 m using a step of 10,000 m where the initial velocity is 1500 m/s upward. Compare your result with the analytical solution.

(c) Discuss some aspects of floating-point representation that have significance regarding computer round-off errors. **(8)**

2. (a) Prove that the optimal step size for the finite-difference approximation can be expressed as $h_{opt} = \sqrt[3]{\frac{3\varepsilon}{M}}$, where ε is the upper bound of the absolute value of each component of the round-off error and M is the maximum absolute value of the third derivative. **(15)**

(b) Discuss a procedure for approximating the error in $f(x)$ given derivative of a function and an estimate of the error in the independent variable. Use appropriate sketches. **(10)**

(c) Manning's formula for a rectangular channel can be written as **(10)**

$$Q = \frac{1}{n}\frac{(BH)^{5/3}}{(B+2H)^{2/3}}\sqrt{S}$$

IPE 329

Contd... Q. No. 2(c)

where Q = flow (m^3/s), n = a roughness coefficient, B = width (m), H = depth (m), and S = slope. You are applying this formula to a stream where you know that the width = 20 m and the depth = 0.3 m. Unfortunately, you know the roughness and the slope to only a ± 10% precision. That is, you know that the roughness is about 0.03 with a range from 0.027 to 0.033 and the slope is 0.0003 with a range from 0.00027 to 0.00033. Use a first-order error analysis to determine the sensitivity of the flow prediction to each of these two factors. Which one should you attempt to measure with more precision?

3. (a) Three masses are suspended vertically by a series of identical springs where mass 1 is at the top and mass 3 is at the bottom. If $g = 9.81 m/s^2$, $m_1 = 2$ kg, $m_2 = 3$ kg, $m_3 = 2.5$ kg, and k's = 10 kg/s^2, solve for the displacements x. **(15)**

   (b) (i) Show that the Gauss-Jordan method requires **(20)**

$$\frac{n^3}{2}+n^2-\frac{n}{2} \text{ multiplication/divisions}$$

and

$\frac{n^3}{2}-\frac{n}{2}$ additions/subtractions.

   (ii) Make a table comparing the required operations for the Gauss-Jordan and Gaussian elimination methods for n = 3, 10, 50, 100. Which method requires less computation?

4. (a) Write a pseudocode to generate the matrix inverse using LU decomposition. **(10)**

   (b) Prove that the local truncation error for the Euler's method is proportional to the square of the step size and the first derivative of the differential equation. **(10)**

   (c) Solve the following problem over the interval from t = 0 to 2 using a step size of 0.5 where $y(0) = 1$. Display all your results on the same graph and then compare them. **(15)**

$$\frac{dy}{dt} = -2y + t^2$$

Obtain your solutions with (i) Heun's method without iterating the corrector, (ii) Heun's method with iterating the corrector until $\varepsilon_s < 0.1\%$, (iii) midpoint method, and (iv) Ralston's method.

SECTION-B

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

5. (a) Two positive real roots for the polynomial $f(x) = x^4 + x^2 - 2$ are $x = 1$ and $x = -1$. Find the other two roots using Muller's method. **(20)**

Contd P/4

IPE 329

Contd... Q. No. 5

(b) Draw the graph of a single function f that satisfies *all* of the following: **(10)**

(i) For all x, function f is defined and differentiable;

(ii) There is a unique root $a > 0$;

(iii) Newton's method will coverage for any $x_0 > a$;

(iv) Newton's method will diverge for all $x_0 < 0$.

(c) Briefly explain a shortcoming of bisection method and how you will overcome it. **(5)**

6. (a) The pressure drop in a section of pipe can be calculated as **(20)**

$$\Delta p = f\frac{L\rho V^2}{2D}$$

where Δp = the pressure drop (Pa), f = the friction factor, L = the length of pipe (m), ρ = density (kg/m^3), V = velocity (m/s) and D = diameter (m). For turbulent flow, the *Colebrook equation* provides a means to calculate the friction factor,

$$\frac{1}{\sqrt{f}} = -2.0\log\left(\frac{\varepsilon}{3.7D} + \frac{2.51}{\mathrm{Re}\sqrt{f}}\right)$$

where ε = the roughness (m), and Re = the *Reynolds number*

$$\mathrm{Re} = \frac{\rho VD}{\mu}$$

where μ = dynamic viscocity (Ns/m^2).

Δp for a 0.20-m-long horizontal stretch of smooth drawn tubing given $\rho = 1.23$ (kg/m^3), $\mu = 1.79 \times 10^{-5}$ (Ns/m^2), $D = 0.005$ (m), $V = 40$ (m/s), and $\varepsilon = 0.0015$ (mm). Use a numerical method to determine the friction factor. Note that smooth pipes with Re < 10^5, a good initial guess can be obtained using the *Blasius formula*, $f = 0.316/\mathrm{Re}^{0.25}$.

(b) A particle starts at rest on a smooth inclined plane whose angle θ is changing at a constant rate **(15)**

$$\frac{d\theta}{dt} = \omega < 0$$

At the end of t seconds, the position of the object is given by

$$x(t) = -\frac{g}{2\omega^2}\left(\frac{e^{\omega t} - e^{-\omega t}}{2} - \sin\omega t\right)$$

Suppose the particle has moved 1.7 ft in 1 s. Find, to within 10^{-5}, the rate ω at which θ changes.

Assume that $g = 32.17$(ft/s^2).

7. (a) The data in the following table gives the actual thermal conductivity data for the element mercury. **(10+5+5)**

Temperature (°K)	300	400	500	600	700
Conductivity (W/cm °K)	0.084	0.098	0.109	0.12	0.127

Contd P/5

IPE 329

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

(i) Use Newton interpolation and the data for 300 K, 500 K, and 700 K to construct a quadratic interpolate for this data.

(ii) How well does it predict the values at 400 K and 600 K?

(iii) Estimate the error for the third-order polynomial interpolation.

(b) Consider the following integral **(7+8)**

$$\int_0^2 1 - e^{-x} dx$$

(i) If the composite trapezoidal rule is to be used to compute this integral, how many intervals will you need if you want to limit the approximate truncation error at 3×10^{-2}?

(ii) Based on the calculation done in (i), show that the approximate truncation error does not exceed the given limit.

8. (a) Evaluate the following integral: **(25)**

$$\int_{-2}^{4} \left(1 - x - 4x^3 + 2x^5\right) dx$$

Use,

(i) Composite trapezoidal rule, with $n = 2$;

(ii) Single application of Simpson's 1/3 rule;

(iii) Multiple application of Simpson's 1/3 rule with $n = 4$;

(iv) Simpson's 3/8 rule;

(v) Simpson's 1/3 rule in conjunction with Simpson's 3/8 rule for $n = 5$.

In each case, compute the true error and indicate which approach provides the highest accuracy.

(b) Graphically depict the convergence and divergence in simple fixed-point iteration. Prove that the convergence in simple fixed point iteration occurs if the magnitude of the slope of $g(x)$ is less than the slope of the line $f(x) = x$. **(10)**

L-3/T-2/IPE **Date : 12/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **IPE 311** (Material Handling and Maintenance Management)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

Assume reasonable values for any missing data.

1. (a) What is Industry 4.0? What is its implication in industrial maintenance? **(10)**

(b) Explain third generation maintenance philosophy with neat sketches. **(10)**

(c) Consider a parallel system made up of two identical units. For system success, at least one unit must operate normally. The system fails when both the units fail. Repair or corrective maintenance begins as soon as a unit fails to return to its operating state. Declare the required assumptions, and parameters/variables to apply the Markov method for the system. Draw the system-state space diagram. Develop the differential equations for the system using the Markov method. Interpret the equations. **(15)**

2. (a) (i) Construct a fault tree diagram (FTD) for the electric motor circuit shown in Figure for Question 2(a). The top event is defined as 'The motor fails to operate'. The other events are defined as follows. **(15+10)**

Event	Description	Probability of occurrence
P1	Defect in motor	0.01
P2	Wire failure (open)	0.01
P3	Power supply failure	0.01
P4	Switch fails open	0.01
P5	Fuse failure under normal conditions (open)	0.01
P6	Wire failure (shorted)	0.01
P7	Power failure (surge)	0.01
S1	Switch opened erroneously	0.001
C1	Fuse fails open	0.50

Note that the overload in the circuit may be caused either by a short or a power surge, both of which are primary (i.e. basic) events.

(ii) Calculate the probability of occurrence of the top event.

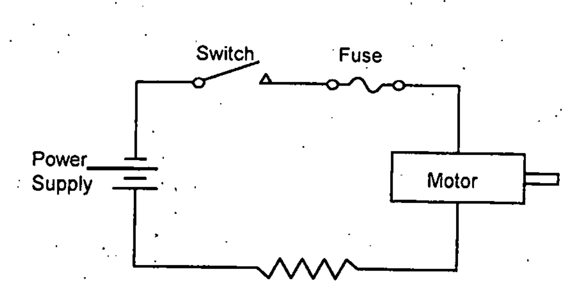


Figure for Question 2(a)

Contd P/2

IPE 311

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

(b) Given the following information, show material flows between machines on a from-to-chart. **(10)**

Component	Production quantity/day	Routing
1	30	A-C-B-D-E
2	12	A-B-D-E
3	7	A-C-D-B-E

Additional information:

Component 1 and 2 have the same size. Component 3 is almost 3 is almost twice as large. Therefore, moving two units of components 1 or 2 equivalent to moving one unit of component 3.

3. (a) List some elements of preventive maintenance (PM). What are the benefits of PM? **(5+5)**

(b) A piece of equipment has 30 parts of a specific type with a failure rate of 20 failures per million hours of operation. Assume that the equipment is operated continuously throughout the day and night and the spares are restocked every 4 months. Calculate the probability of having a spare part available when required, if only 4 spare parts are carried in inventory. **(10)**

(c) An aircraft maintenance project has the following information. **(7+4+4=15)**

Activity	Successor	Time estimates (week)
A	D	4
B	E, F	7
C	G	3
D	I	6
E	H	4
F	J	7
G	J	6
H	K	10
I	K	3
J	-	4
K	-	2

Required:

(i) Draw the network diagram. Display all required information on each activity.

(ii) What are the critical activities?

(iii) What are the significance of identifying the critical activities for the maintenance project?

4. (a) Define three key performance indicators that can be used for evaluating performance of maintenance activities of an organization. **(6)**

(b) How can you apply fuzzy logic/fuzzy set theory for machine health condition monitoring? **(5)**

(c) List the pillars of Total Productive Maintenance (TPM). Which pillar should be considered first to start TPM program in an organization? Detail your suggested pillar. **(4+10=14)**

(d) How can you establish optimum preventive maintenance policies for a manufacturing organization? Show the necessary computations. **(10)**

SECTION-B

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

5. (a) What are the characteristics required in the pulling member of a conveyor? Differentiate among belt, chain and ropes as pulling members used in different types of conveyors. **(15)**

   (b) Write down the purposes of using take up devices in conveyors? Discuss about the applications, advantages and disadvantages of different types of take-up devices. **(12)**

   (c) What are the required properties of conveyor belt? Discuss the function of rubber and fabric plies in rubberized textile belt. **(8)**

6. (a) With neat sketches, show the following types of drives. **(4)**

   (i) Drives with snub pulley

   (ii) Drives with pressure belt

   (b) Show the components of a screw conveyor with a neat sketch. **(5)**

   (c) Mention the benefits and difficulties faced with screw conveyors. **(5)**

   (d) For an unpowered roller conveyor, derive the equation of resistance to motion factor. **(15)**

   (e) An unpowered roller conveyor having a length of 8m is designed to carry 20 kg of total resistance to motion per meter of length and employed to convey unit loads. Roller diameter is 8cm, journal diameter is 2.5 cm, weight of roller is 1kg, K = 85%, $\mu = 0.15$ and k = 0.005m. If there remains total 80 rollers and 3 rollers can carry each load, find the maximum weight of each unit load. **(6)**

7. (a) Suppose, a bucket elevator is necessary to elevate charcoals in a factory. For this purpose suggest appropriate type of bucket, bucket arrangement, speed, method of charging and discharging with justification. **(15)**

   (b) A flanged apron conveyor (Fig. 7b) is designed to deliver iron cylinders of a diameter 500 mm, a height of 270 mm and a piece weight G = 250 kg. The conveyor capacity Z is 250 pieces per hour with an irregularity factor $K' = 2.5$. If apron width is 750 mm, A = 150, minimum load spacing a = 900 mm, K = 1.08 and resistance to motion factor, $\omega' = 0.13$, find the tensions at different points. Here, H = 4.0 m and $\alpha = 20°$. **(20)**

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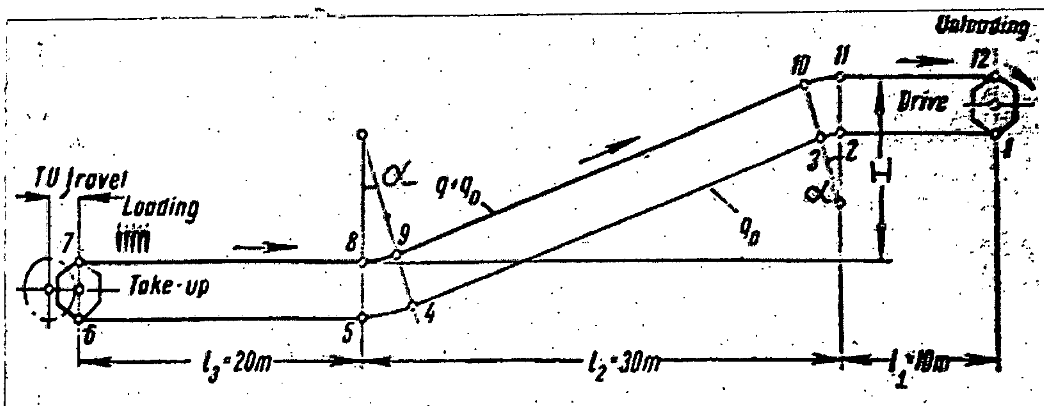

Fig.:7b

8. (a) Suppose, you are studying a system comprised of two machines and monitoring the state of the system every hour. A given machine operating at time n has probability p of failing before the next observation at time $n + 1$. A machine that was in a failed condition at time n has probability r of being repaired by time $n + 1$, independent of how long the machine has been in a failed state. The machine's failures and repairs are mutually independent events. Let X_n be the number of machines in operation at time n. The process X_n, $n = 0, 1, \ldots$ is a discrete time homogenous Markov chain with state space

$I = 0, 1, 2.$ **(12+10=22)**

(i) Determine the system's transition probability matrix.

(ii) Obtain the steady state probability vector, if it exists.

(b) How can you apply Hollier algorithm to establish ordering of machines for minimizing backtrack material flows? Illustrate with a numerical example. **(13)**