L-4/T-1/IPE **Date : 03/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **IPE 317** (Product Design II)

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**.

The text book titled "Shigley's Mechanical Engineering Design" is supplied.

Assume reasonable values for any missing data.

1. (a) Design a cross belt drive using a flat belt to connect two parallel horizontal shafts having a central distance of 5m. The driving shaft rotates at 900 rpm and transmits 75 KW power under medium shock. The velocity ratio is to be 3:1 and design factor should be 1.1. The maximum values of the diameter of the driving pulley and belt width can be 335 mm and 330 mm respectively. **(25)**

   (i) Select pulley diameter, belt material and belt width.

   (ii) If the vertical deflection of the catenary curve is 15 mm, is the belt able to provide sufficient initial tension?

   (b) A steel disk break is used to stop the rotation of a shaft in a machine at a cyclic order. The rotary inertia of the machine as seen from brake shaft is 29 Kg. m.s. The density of the disk is 7800 Kg/m^3, specific heat capacity is 0.45 Kj/(Kg. °C), volume is 120×10^{-6} m^3, and lateral area of the brake surface is 0.025m^2. Air circulates at 12 m/s around the lateral surface and ambient temperature is 21°C. At steady state, if the maximum and the minimum temperatures are to be kept at 100°C nad 75°C respectively, find the rpm of the rotary shaft and the minimum time interval that must be maintained between two consecutive braking. **(10)**

2. (a) Choose an Oiles 500 bushing that can withstand a maximum wear of 0.03 mm to be used with a journal bearing rotating at 350 rpm and to carry 250 N radial load. Use h_{CR} = 15 W/(m^2.°C) and design factor 1.5. If the maximum Temperature is 200°C, select the dimensions of the bearing to maximize the bearing life. (J = 1 m.N/J, T_α = 26°C) **(15)**

   (b) In the following Figure-1, an electric motor transmits 1.2-hp at 1500 rev/min in the counter clockwise direction, as viewed from the positive x axis. Keyed to the motor shaft is an 20-tooth helical pinion having a normal pressure angle of 20°, a helix angle of 30°, and a normal diametral pitch of 10 teeth/in. The no. of teeth of gear is 45. The hand of the helix is shown in the figure. Make a three-dimensional sketch of the gear shaft 2, and show the forces acting on the gear and the bearing reactions at C and D. **(20)**

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3. Design a worm gear mesh to connect a 1.2 hp induction motor to a liquid agitator. The motor speed is 100 rpm and the velocity ratio is to be 5:1. Use 1.5 in pitch diameter for the worm, 4 teeth/in tangential diametral pitch for the gear, 25° normal pressure angle. The ambient temperature is 70°F, application factor is 1.3 and design factor is 1. Use hardened steel worm and Chilled bronze worm gear. **(35)**

   (i) Check whether the tangential force on, the worm gear is within allowable limit for bending and wear.

   (ii) Design sufficient case lateral area.

   (iii) Find AGMA bending stress

4. In the following Figure-2, shaft 1 is connected to a 20 KW power source and rotates at 1800 rpm. The output shaft 3 is required to rotate at right angle within the range of 100-120 rpm. The gear box size should be kept minimum. Design the gear box for commercial use to provide uniform power transmission with life greater than 12000 hours. The bearings are located at a, b, c, d, and e. Assume any data required. **(35)**

   (i) Find the required no. teeth of the gears A, B, C, and D. A and B are straight bevel gears; and C and D are spur gears.

   (ii) Torque in shaft 1, 2, and 3.

   (iii) Select diameters of the gears and find the acting forces.

   (iv) For gear B check the factor of safety for wear.

   (v) For shaft 2 select appropriate type of bearing at b and c.

SECTION – B

There are **FOUR** questions in this Section. Answer Q. No. 5 and any **TWO** from the rest.

5. (a) Fig. 5(a). represents hydraulic circuit of an excavator where the labeling 50 and 51 represent variable displacement hydraulic pump, 53 and 61 represent bidirectional hydraulic motor, 54 and 62 represent travelling control valves, 66 and 68 represent control valves for boom cylinders (64), 67 for bucket cylinder (65), 59 and 76 for arm cylinder, 58 for swiveling motor (56) and 52, 60 represent center bypass line. With the help of Reliability Block diagram (RBD), derive equation for determining reliability of the hydraulic circuit shown in Fig. 5(a). **(21)**

   (b) Vermeer D36×50DR Series II is a horizontal drill machine. Assume, to design it for reliability, firstly one needs to allocate target reliability to all its components/subsystems after determining their reliability for different hours of operation. Next, one needs to determine the system availability. Then, one needs to conduct uncertainty analysis on evaluated availability for different hours of operation. Now, answer the following

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

questions considering Weibull distribution to be followed by all its subsystems for its reliability and availability estimation.

(i) Initial reliability values of horizontal drill machine's three subsystems are shown in Fig. 5(b-i) for different hours of operation. Vindicate that reliability of Frame and Cab are 0.311 and 0.996 for 5000 and 2000 hours of operation, respectively. Assume Weibull Slope is 2. Comment on the difference in value of reliability of Frame and Cab for certain hour of operation (Assume 2000 hour) despite having same Weibull slope. **(7)**

(ii) How can you determine the shape of the Time Vs Mean availability graph as represented in Fig. 5(b-ii)? Explain. Also mention the difference between mean availability and point availability of the system considered. **(7)**

(iii) Fig. 5(b-iii) represents uncertainty estimation of the considered system. Do you think, for a certain hour of operation, there is presence of randomness in hazard rate for upper bound or lower bound estimation of availability? Justify. Also, quantitatively explain the reason of using confidence interval in determining such bound. **(10)**

6. (a) Define the classification of Stochastic point processes in modeling a repairable system. Write down handling and accessibility guidelines from design for maintainability perspective. **(4+6)**

(b) Each of Fig. 6(a-i) and Fig. 6(a-ii) either correspond to guidelines of design for manufacturing (DFM) of infection molded parts or cast parts. Which figure correspond to which guidelines of DFM? In each figure, there are two pictures; which one should you do and which one you should not? Why? Do you think there is a contradiction between these two figures (Fig. 6(a-i) and Fig. 6(a-ii)? Justify your answer. **(10)**

(c) A system has a lognormal repair distribution with a median time to repair of 3.5 hour and with variance of 0.0324 for the distribution of logarithm of repair time. Specification call for 95 percent of the maintenance to be completed within 5 hour and the number of maintenances must be performed every 200 operating hours to be less than 3 hours for every 100 operating hours. To maintain warranty, a 2-hour preventive maintenance must be performed every 200 operating hours. The crew size is always two for safety reasons. The failure distribution is exponential with an MTBF of 1000 operating hours. Are the specifications being met? Also determine mean system downtime. **(10)**

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7. (a) Write down the steps of Life cycle assessment. How can you relate it with supply chain? **(8)**

   (b) Determine DFA complexity factor, Theoretical part count efficiency and practical part count efficiency of the stapler as shown in Fig. 7(b). What are the secondary operations required here? (Assume, Staples (5) is not a part of this assembly) **(22)**

8. (a) Consider the structure in Fig. 8(a) where load on A is shared by B and C. Now answer the following questions

   (i) Derive the generalized equation for determining reliability of any of the component (A or B or C) using dynamic physical reliability model. Assume stress and strength of all components are random. **(7)**

   (ii) Derive general reliability model of the whole system dropping physical reliability consideration and deduce it for exponential distribution. **(7)**

   (iii) Have you considered degradation in any of the above model? If not, how can you include them? **(4)**

   (b) An angular-contact, inner ring rotating, 02-series ball bearing is required for an application in which the life requirement is 40 kh at 520 rev/min. The design radial load is 725 Ibf. The application factor is 1.4. The reliability goal is 0.90. Find the multiple of rating x_D required and the catalogue rating C_{10}. Choose a bearing and estimate the existing reliability in service. **(12)**

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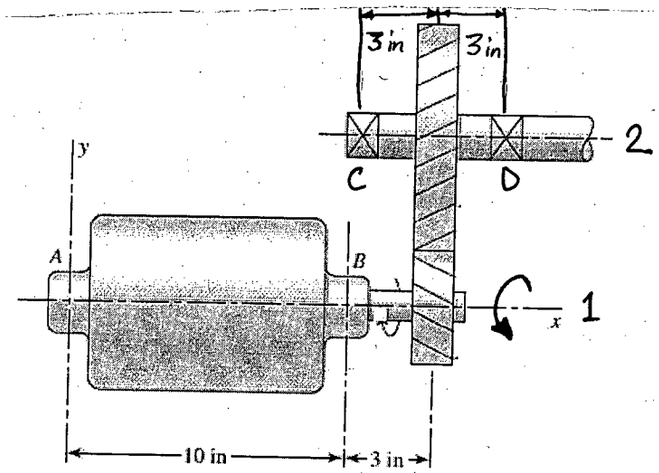

Figure – 1.

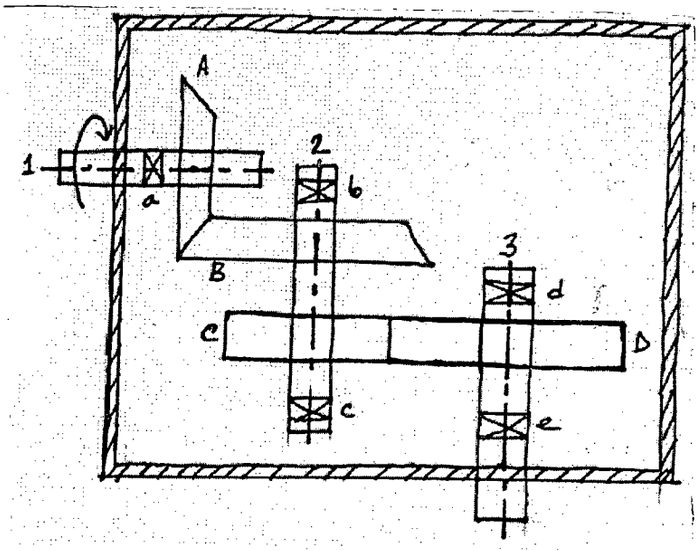

Figure – 2.

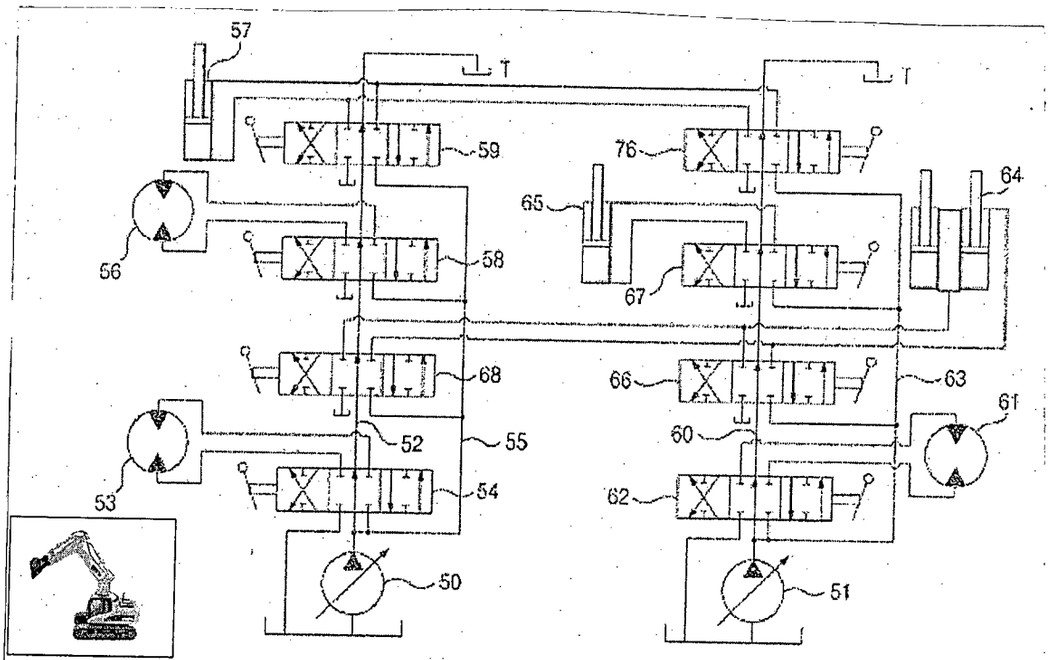

Fig. 5(a)

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Subsystem/operational time (hr)	Frame	Cab	Engine
50	0.999	0.999	0.998
100	0.999	0.999	0.993
200	0.998	0.999	0.974
500	0.988	0.999	0.848
1000	0.954	0.999	0.518
2000	0.830	0.996	0.071
5000	0.311	0.975	≈0

Fig. 5(b-i)

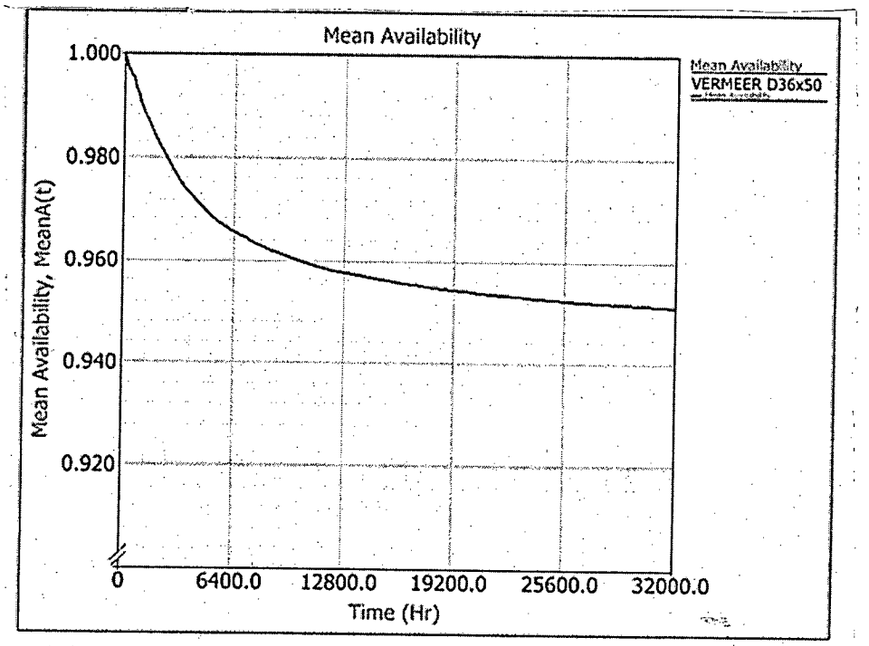

Fig. 5(b-ii)

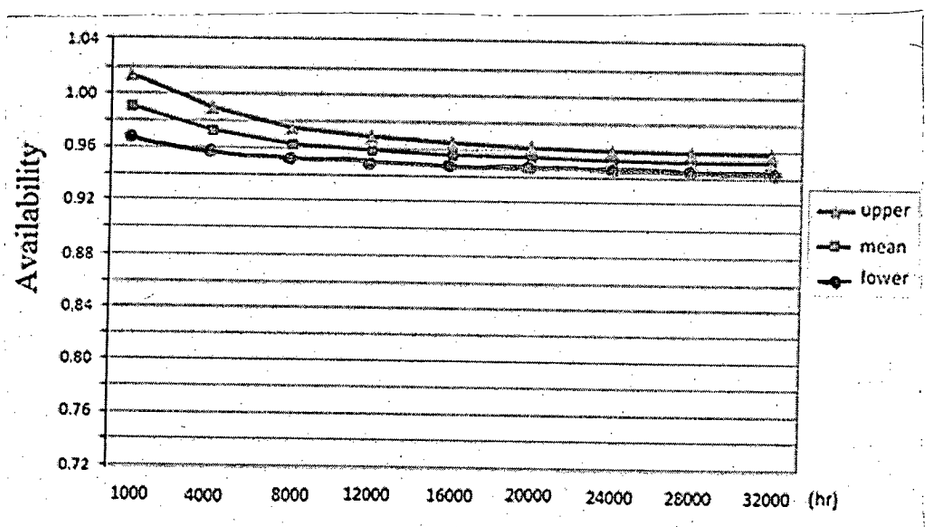

Fig. 5(b-iii)

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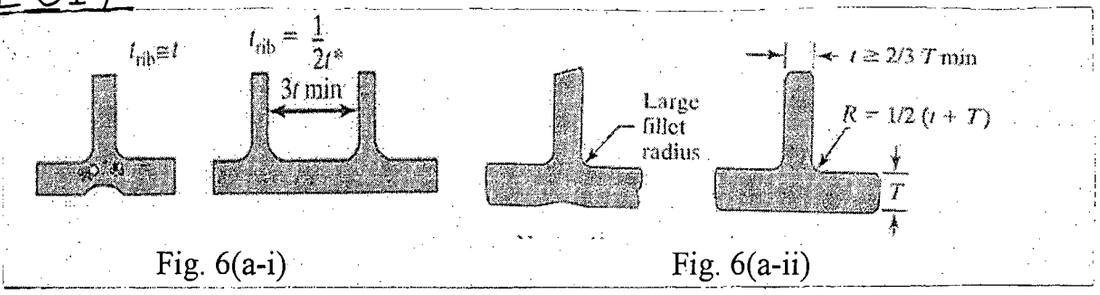
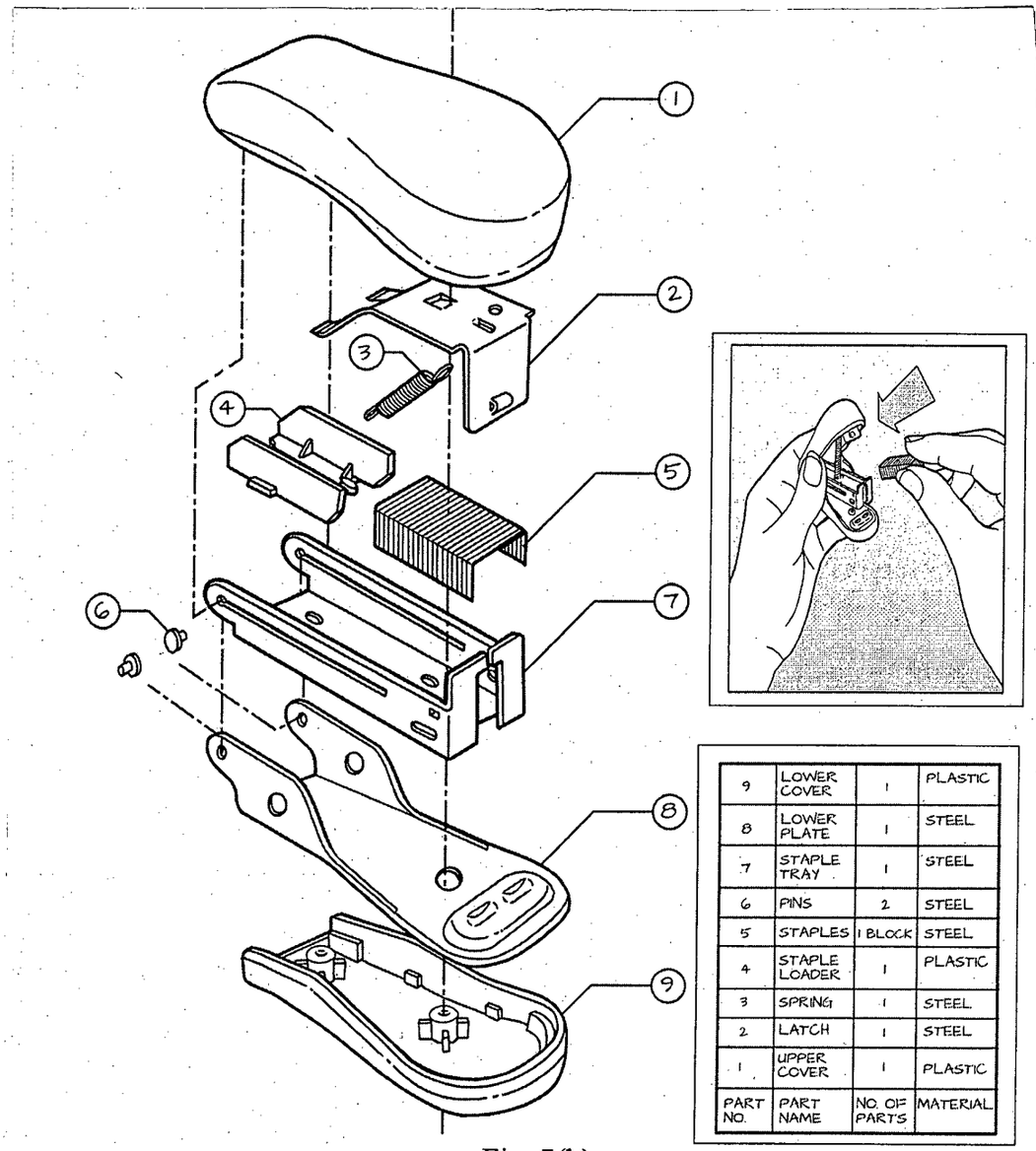


Fig. 6(a-i) Fig. 6(a-ii)



PART NO.	PART NAME	NO. OF PARTS	MATERIAL
9	LOWER COVER	1	PLASTIC
8	LOWER PLATE	1	STEEL
7	STAPLE TRAY	1	STEEL
6	PINS	2	STEEL
5	STAPLES	1 BLOCK	STEEL
4	STAPLE LOADER	1	PLASTIC
3	SPRING	1	STEEL
2	LATCH	1	STEEL
1	UPPER COVER	1	PLASTIC

Fig. 7(b)

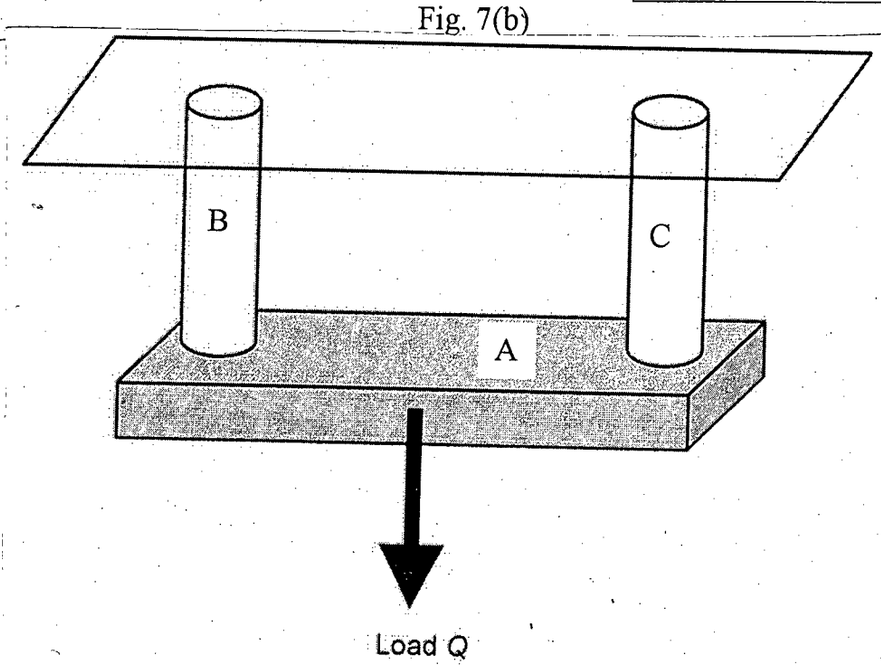


Fig. 8(a)

L-4/T-1/IPE **Date : 12/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **IPE 451** (Supply Chain Management)

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) Differentiate "Sell-in" and "Sell through" in a supply chain. Give example for both. **(15)**

   (b) Explain "Pricing Obstacle" in a supply chain with appropriate example. **(20)**

2. (a) Water is a major mode of transport. Explain its characteristics. **(15)**

   (b) Which Design options for transportation network are used by Wal-Mart and 7-Eleven? Explain with necessary diagrams. **(20)**

3. (a) What are the different kinds of discounts in purchasing? Explain. **(15)**

   (b) Antler Co. Ltd. buys hard disk, microprocessor and keyboard from Tanin Co. Ltd. at a price of 5 $, 10 $ and 15 $ respectively. Annual demands of those components are 1500 pieces, 1000 pieces and 500 pieces respectively. Holding cost for all components are 15% of the value of stock. Product specific ordering costs are 60 $, 30 $ and 10 $ respectively. Antler decided to buy all components together under the same order, i.e. lots are ordered and delivered jointly for all components. If annual ordering cost for all components together is 612.4 $/year, then what is the common ordering cost per order? **(20)**

4. (a) Describe, in brief, the sourcing strategy followed by Japanese automotive industry. **(15)**

   (b) Daily demand of coal at Unique Foundry Ltd. is Normally distributed with mean demand 2000 kilograms/day and standard deviation 200 kilograms. They buy coal from a coal miner, who takes an average lead time of 3 days, with standard deviation of 1 day. Unique wants to be 97.5% sure of not having stockout. They buy 32,000 kgs of coal in one order. **(8+6+6)**

   (i) What is the safety stock amount?

   (ii) How many days' safety stock do they maintain?

   (iii) Show the values on a Standard Normal Distribution diagram.

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SECTION – B

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

5. (a) "Supply chain can be thought of an integration of three major area of knowledge"- justify this statement by explaining all the major constituents of supply chain. **(15)**

   (b) Differentiate between milk runs and cross-docking by explaining them with suitable practical examples. **(15)**

   (c) Why should an online seller as Amazon build more warehouses as its sales volume grows? **(5)**

6. (a) Which distribution network requires higher level of inventory that any other distribution network? Explain it briefly. **(15)**

   (b) Explain the cost-efficient responsive frontier. Can you achieve responsiveness and efficiency at the same time? **(12)**

   (c) How customer values are influenced by the structure of distribution network? **(8)**

7. (a)State and explain a positive impact and a negative impact that online sales have on supply chain cost. **(15)**

   (b) Despite Dell's tremendous success on their strategy of making customized personal computers, the changing marketplace has posed some new challenges. Explain what those challenges are and how Dell has responded to those challenges. **(12)**

   (c) Exhibit the value chain of a typical organization. What do you understand by the product development strategy and supply chain strategy? **(8)**

8. (a) Presently, Apple and Samsung are seen as the largest manufactures of Smartphones across the world. Earlier, the mobile phone market was ruled by companies like Nokia an Motorola but Apple took over the market when it launched 'iPhone' in 2007. The product became actually popular among users because of its unique innovation and high brand value. Whereas, Samsung gained wide acceptability due to its wide range of collection- from low price to high price. How do these two companies differ in achieving their respective strategic fit? **(20)**

   (b) How does Wal-Mart use all the supply chain drivers to achieve the right balance between efficiency and responsiveness so that its competitive strategy and supply chain strategy align with each other? **(15)**

L-4/T-1/IPE **Date : 18/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **IPE 407** (Ergonomics and Safety Management)

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) "Doing any work by flexing the trunk may lead to more compressive and shear stresses at L5/S1 joint without any load at any hand. With load at any hand those stresses increase further." Justify these statements with necessary schematics. **(15)**

   (b) How strengthening core muscle may save you from spinal disk degeneration at an early age? Explain from biomechanical point of view. **(6)**

   (c) How does NIOSH lifting equation agglomerate physiological and psychophysical approaches? Why this congregation is necessary? Explain. **(8)**

   (d) Discuss the main shortcomings of: **(6)**

   (i) Rapid Upper Limb Assessment (RULA) method over Ovako Working-posture Assessment (OWAS) method.

   (ii) Ovako Working-posture Assessment (OWAS) method over Rapid Upper Limb Assessment (RULA) method.

2. (a) Evaluate final OWAS and final RULA scores considering the posture shown in Fig. 2(a). **(20)**

   - 40 lb is required for the task.
   - Workers expose to this posture 14% of their working hours.
   - Approximate other necessary data from Fig. 2(a).

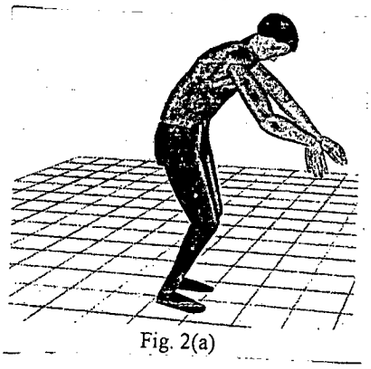

Fig. 2(a)

   (b) How can you restore bad neck curve? Explain with necessary schematics. **(8)**

   (c) Consider again Fig. 2(a) and answer the following questions: **(7)**

   (i) Which type of pelvic tilt occurs there?

   (ii) Which muscles are included in this type of pelvic tilt? How do they affect your back and neck?

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3. (a) Consider the following given data: **(20)**

Distances of the hands away from the mid-point between the ankles are 21 inches and 10 inches at the origin and destination, respectively.

- The worker completes this operation once per minute for a continuous duration of 8 hours
- The first lift (from table to the box) requires significant control at the destination.
- The second lift (from box to pallet) does not require significant control at the destination.
- Rolls of paper weigh 25 lbs.
- The worker does not twist when lifting the rolls of paper.

Evaluate whether the work is hazardous or not. Also, provide redesign suggestions and recheck the hazardous criteria with your redesign suggestions.

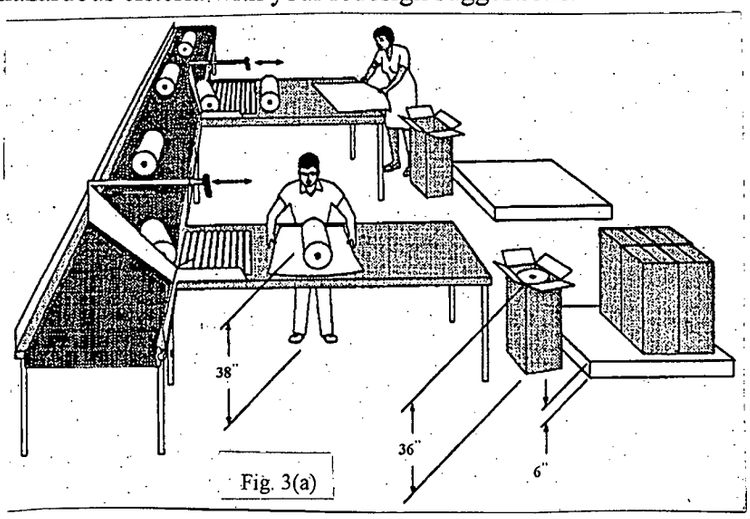

Fig. 3(a)

(b) What input data are required to perform ergonomic analysis using Snook Table? Explain. **(5)**

(c) **(10)**

(i) A person regularly carries a bucket with a handle, which does not have a proper grip, a number of times during the day. What problems he may have in his hand and why?

(ii) To circumvent the problem, one of the ergonomic solutions is to redesign the bucket handle like Fig. 3(c). How such redesign may solve the former problems. Explain.

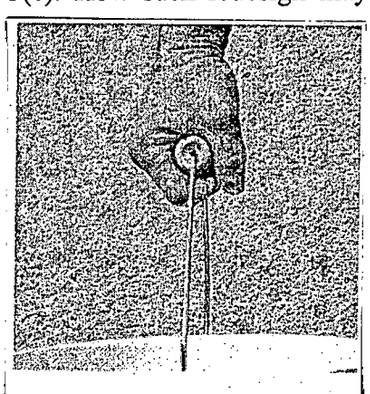

Fig. 3(c)

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4. (a) **(7+7)**

(i) What is the inverse dynamics? Why is the inverse dynamics required to model human body for ergonomic analysis?

(ii) How can you perform ergonomics analysis of human body using the inverse dynamics? Explain quantitatively.

(b) What is the static strength prediction? How does it help in ergonomic analysis? **(7)**

(c) What is the difference between muscle spasm and muscle cramp? With what preventive measures you can avoid them? **(7)**

(d) What are the lighting design considerations for a video display terminal (VDT)? Explain any two considerations in brief. **(7)**

SECTION – B

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

5. (a) Write a short note of Boiling-Liquid Expanding-Vapor Explosions (BLEVE). **(10)**

(b) Explain the flammability diagram with an appropriate example. **(12)**

(c) Fires and explosions are substantial hazards in many chemical plants. **(13)**

(i) Describe with examples the three ingredients of any fire.

(ii) Create a checklist with at least six items to identify fire hazards in any workplace.

(iii) List six common fire prevention/protection features for chemical plants, and describe when they are appropriate.

6. (a) Describe the normal procedure for using hazards identification and risk identification (HAZOP). **(12)**

(b) A diagram of the safety systems in a certain chemical reactor is shown in Fig. 6(b). This reactor contains a high-pressure alarm to alert the operator in the event of dangerous reactor pressures. It consists of a pressure switch within the reactor connected to an alarm light indicator. For additional safety an automatic high-pressure reactor shutdown system is installed. This system is activated at a pressure somewhat higher than the alarm system and consists of a pressure switch connected to a solenoid valve in the reactor feed line. The automatic system stops the flow of reactant in the event of dangerous pressures. Compute the overall failure rate, the failure probability, the reliability, and the MTBF for a high-pressure condition. Assume a 1-yr period of operation. Also, develop an expression for the overall failure probability based on the component failure probabilities. Use the failure rate data from the table 6(b). **(10)**

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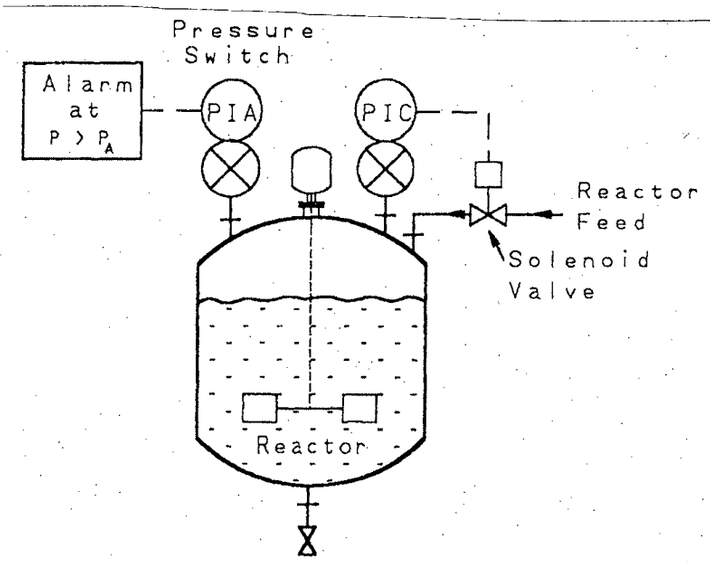

A chemical reactor with an alarm and an inlet feed solenoid. The alarm and feed shutdown systems are linked in parallel.

Fig. 6(b)

(c) Explain the following fire related events: (i) Backdraft (ii) Flash Fire (iii) Fireballs. **(8)**

(d) Explain with examples how a company can reduce loss exposures by means of substitution and risk transfer. **(5)**

7. (a) Explain the classification process of liquids based on their flammability. **(10)**

(b) Illustrate some challenges for implementing occupational health and safety problem in the tobacco industry of Bangladesh. Cite suitable examples to support your answer. **(10)**

(c) Narrate Heinrich's Domino theory of accident causation with appropriate examples in the context of manufacturing industries of Bangladesh. **(10)**

(d) Briefly explain toxicology with the help of a dose-response relationship diagram. **(5)**

8. (a) Develop an affective noise conservation program for a manufacturing company in order to control the noise level in the production floor. **(10)**

(b) Differentiate between variant method and generative method. Describe the grasp posture generation method for a particular object with necessary figures. **(13)**

(c) How can you design flexible seat depth for an office chair? **(12)**

Table 6(b) Failure Rate Data for Various Selected Process Components[1]

Instrument	Faults/year
Controller	0.29
Control valve	0.60
Flow measurement (fluids)	1.14
Flow measurement (solids)	3.75
Flow switch	1.12
Gas-liquid chromatograph	30.6
Hand valve	0.13
Indicator lamp	0.044
Level measurement (liquids)	1.70
Level measurement (solids)	6.86
Oxygen analyzer	5.65
pH meter	5.88
Pressure measurement	1.41
Pressure relief valve	0.022
Pressure switch	0.14
Solenoid valve	0.42
Stepper motor	0.044
Strip chart recorder	0.22
Thermocouple temperature measurement	0.52
Thermometer temperature measurement	0.027
Valve positioner	0.44

[1]Selected from Frank P. Lees, *Loss Prevention in the Process Industries* (London: Butterworths, 1986), p. 343.

Table 1: OWAS Evaluation for trunk posture

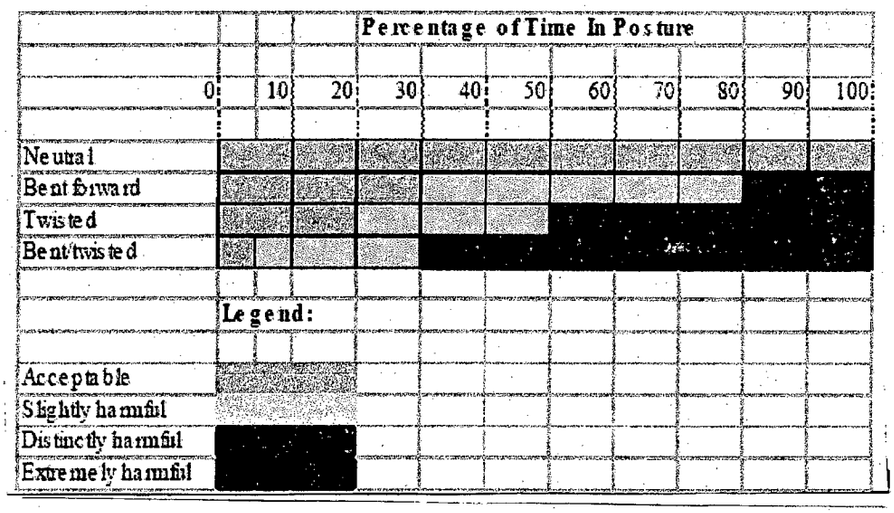

Table 2: OWAS Evaluation for arm posture

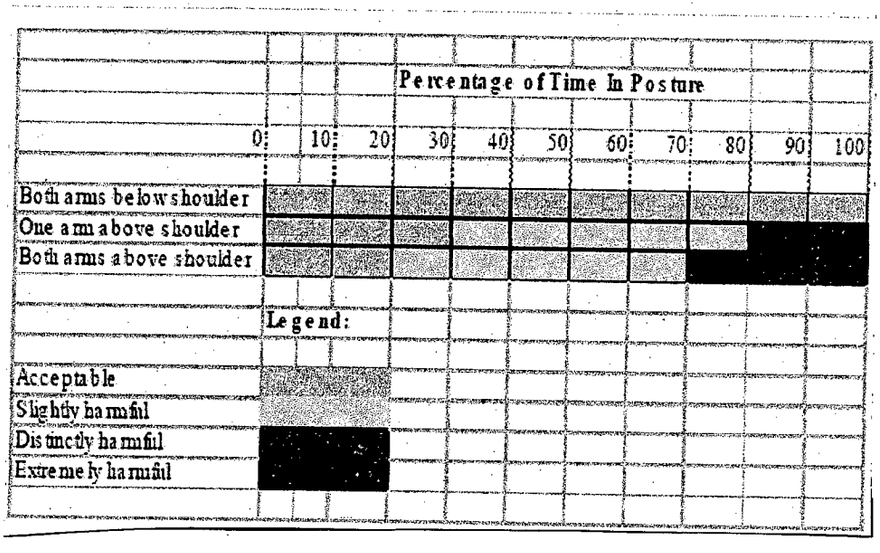

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Table 3: OWAS Evaluation for lower body posture

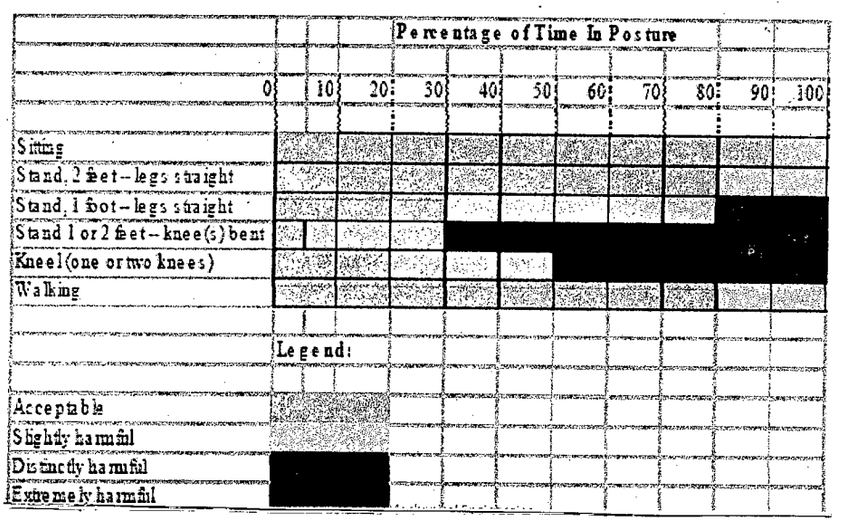


Table 4: OWAS Evaluation for head and neck posture

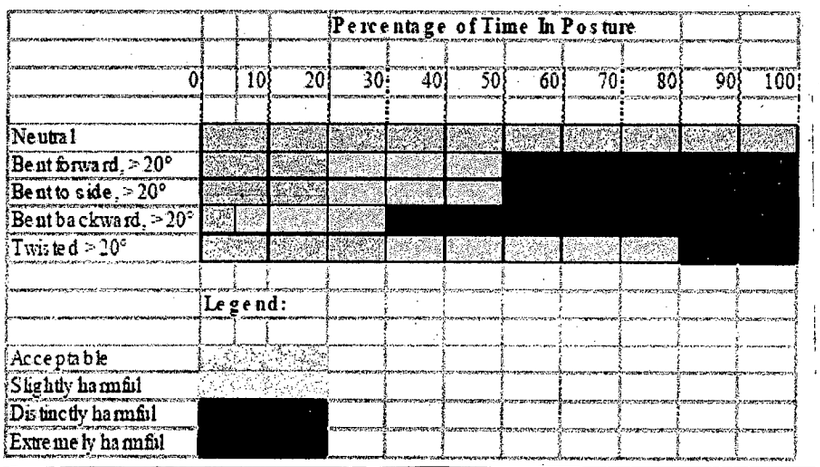


Table 5: Horizontal Multiplier

H	HM	H	HM
in		cm	
≤10	1.00	≤25	1.00
11	.91	28	.89
12	.83	30	.83
13	.77	32	.78
14	.71	34	.74
15	.67	36	.69
16	.63	38	.66
17	.59	40	.63
18	.56	42	.60
19	.53	44	.57
20	.50	46	.54
21	.48	48	.52
22	.46	50	.50
23	.44	52	.48
24	.42	54	.46
25	.40	56	.45
>25	.00	58	.43
		60	.42
		63	.40
		>63	.00

Contd.... P/7

Table 6: Vertical Multiplier

V	VM	V	VM
in		cm	
0	.78	0	.78
5	.81	10	.81
10	.85	20	.84
15	.89	30	.87
20	.93	40	.90
25	.96	50	.93
30	1.00	60	.96
35	.96	70	.99
40	.93	80	.99
45	.89	90	.96
50	.85	100	.93
55	.81	110	.90
60	.78	120	.87
65	.74	130	.84
70	.70	140	.81
>70	.00	150	.78
		160	.75
		170	.72
		175	.70
		>175	.00

Table 7: Distance Multiplier

D	DM	DM	DM
in		cm	
10	1.00	25	1.00
15	.94	40	.93
20	.91	55	.90
25	.89	70	.88
30	.88	85	.87
35	.87	100	.87
40	.87	115	.86
45	.86	130	.86
50	.86	145	.85
55	.85	160	.85
60	.85	175	.85
70	.85	>175	.00
>70	.00		

Table 8: Asymmetric Multiplier

A	AM
deg	
0	1.00
15	.95
30	.90
45	.86
60	.81
75	.76
90	.71
105	.66
120	.62
135	.57
>135	.00

Contd.... P/8

Table 9: Frequency Multiplier Table (FM)

Frequency Lifts/min (F)	Work Duration					
	≤1 Hour		1 but ≤ 2 Hours		2 but ≤ 8 Hours	
	V < 30 t	V ≥30	V< 30	V ≥30	V< 30	V≥ 30
≤0.2	1.00	1.00	.95	.95	85	.85
0.5	.97	.97	.92	.92	81	.81
1	.94	.94	.88	.88	75	.75
2	.91	.91	.84	.84	65	.65
3	.88	.88	.79	.79	55	.55
4	.84	.84	.72	.72	45	.45
5	.80	.80	.60	.60	35	.35
6	.75	.75	.50	.50	27	.27
7	.70	.70	.42	.42	22	.22
8	.60	.60	.35	.35	18	.18
9	.52	.52	.30	.30	00	.15
10	.45	.45	.26	.26	00	.13
11	.41	.41	.00	.23	00	.00
12	.37	.37	.00	.21	00	.00
13	.00	.34	.00	.00	00	.00
14	.00	.31	.00	.00	00	.00
15	.00	.28	.00	.00	00	.00
>15	.00	.00	.00	.00	00	.00

Table 10: Design consideration for Hand-to-Container Coupling Classification

1. An optimal handle design has .75 - 1.5 inches (1.9 to 3.8 cm) diameter, > 4.5 inches (11.5 cm) length, 2 inches (5 cm) clearance, cylindrical shape, and a smooth, non-slip surface.
2. An optimal hand-hold cut-out has the following approximate characteristics: ≥ 1.5 inch (3.8 cm) height, 4.5 inch (11.5 cm) length, semi-oval shape, ≥ 2 inch (5 cm) clearance, smooth non-slip surface, and ≥ 0.25 inches (0.60 cm) container thickness (e.g., double thickness cardboard).
3. An optimal container design has ≤ 16 inches (40 cm) frontal length, ≤ 12 inches (30 cm) height, and a smooth non-slip surface.
4. A worker should be capable of clamping the fingers at nearly 90^0 under the container, such as required when lifting a cardboard box from the floor.
5. A container is considered less than optimal if it has a frontal length > 16 inches (40 cm), height > 12 inches (30 cm), rough or slippery surfaces, sharp edges, asymmetric center of mass, unstable considered bulky if the load cannot easily be balances between the hand-grasps.
6. A worker should be able to comfortably wrap the hand around the object without causing excessive wrist deviations or awkward postures, and the grip should not require excessive force.

Table 11: Coupling Multiplier

Coupling Type	Coupling Multiplier	
	V < 30 inches (75 cm)	V≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

Contd..... P/9

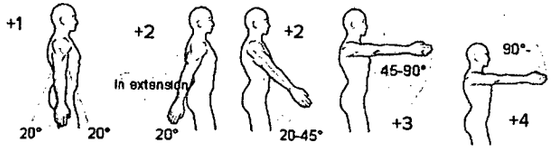
Table 12:

RULA Employee Assessment Worksheet

Task Name: Date:

A. Arm and Wrist Analysis

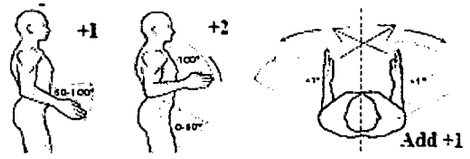
Step 1: Locate Upper Arm Position:



Step 1a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

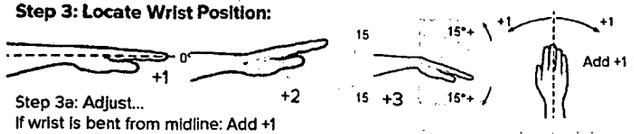
Step 2: Locate Lower Arm Position:



Lower Arm Score

Step 2a: Adjust...
If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:



Step 3a: Adjust...
If wrist is bent from midline: Add +1

Step 4: Wrist Twist:
If wrist is twisted in mid-range: +1
If wrist is at or near end of range: +2

Wrist Twist Score

Wrist Score

Step 5: Look-up Posture Score in Table A:
Using values from steps 1-4 above, locate score in Table A

Posture Score A

Step 6: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

Step 7: Add Force/Load Score
If load < 4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

Step 8: Find Row in Table C
Add values from steps 5-7 to obtain
Wrist and Arm Score. Find row in **Table C**.

Wrist & Arm Score

Scores

Table A

Upper Arm	Lower Arm	Wrist Score 1 Wrist Twist 1	2	2	3	3	4	4
		1	2	1	2	1	2	1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table C

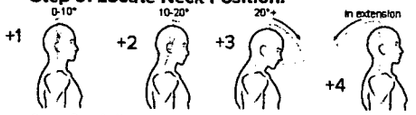
Wrist / Arm Score	Neck, Trunk, Leg Score 1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Scoring: (final score from Table C)
1-2 = acceptable posture
3-4 = further investigation, change may be needed
5-6 = further investigation, change soon
7 = investigate and implement change

RULA Score

B. Neck, Trunk and Leg Analysis

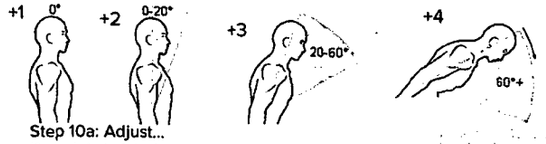
Step 9: Locate Neck Position:



Neck Score

Step 9a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 10: Locate Trunk Position:



Step 10a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 11: Legs:
If legs and feet are supported: +1
If not: +2

Leg Score

Table B: Trunk Posture Score

Neck Posture Score	1 Legs 1	1 Legs 2	2 Legs 1	2 Legs 2	3 Legs 1	3 Legs 2	4 Legs 1	4 Legs 2	5 Legs 1	5 Legs 2	6 Legs 1	6 Legs 2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	9	9	9	9	9	9

Step 12: Look-up Posture Score in Table B:
Using values from steps 9-11 above,
locate score in Table B

Posture B Score

Step 13: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

Step 14: Add Force/Load Score
If load < 4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

Step 15: Find Column in Table C
Add values from steps 12-14 to obtain
Neck, Trunk and Leg Score. Find Column in **Table C**.

Neck, Trunk, Leg Score

Original Worksheet Developed by Dr. Alan Hedge. Based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

L-4/T-1/IPE **Date : 24/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **IPE 403** (Project and Environmental Management)

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) Regarding special demand on Project Manager, "Breadth of communication" and negotiation are closely related with each other- discuss. **(6)**

(b) Three different stages are necessary for Partnering in negotiation. Briefly explain those. **(8)**

(c) Every planning starts with "Statement of Work" – Justify along with its components. **(6)**

(d) For the following task table, calculate project duration, find the critical path and calculate free slack for each task using AON diagram: **(15)**

Task	Successor	Duration (days)		
		Optimistic	Most Likely	Pessimistic
I	----	5	6	7
B	D	2	3	4
F	H, I	7	8	9
C	E, F	3	4	5
H	----	5	6	7
D	F, G	5	6	7
A	C	4	5	6
E	H	6	7	8
G	I	7	8	9

2. (a) Provide appropriate examples of "Backward Integration" and "Forward Integration" projects. **(6)**

(b) Cybernatic control is more appropriate for products rather than service- do you agree? Justify your answer with examples. **(6)**

(c) Objective is included in Project Plan/Proposal report although this is a separate stage before plan- why? **(3)**

(d) Calculate all possible crash times and corresponding costs for the following table: **(20)**

Activity	Predecessor	Duration		Cost (USD)	
		Normal	Crash	Normal	Crash
a	----	3	3	40	40
b	a	3	2	20	50
c	a	3	3	20	20
d	a	4	2	50	110
e	b	3	1	10	70
f	d	2	1	30	50

Contd P/2

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3. (a) What is work breakdown structure? What are the four conditions of a task to be broken down into subtasks – explain. **(8)**

(b) Project manager should have some special criteria to be selected in the mentioned post- elaborate those criteria. **(8)**

(c) Successful negotiation should be a "Win-Win" situation for both parties- justify. **(4)**

(d) For the following activity table, prepare a work schedule by leveling manpower resources: **(15)**

Activity	Duration (wk)	Manpower Requirement
1-2	6	16
1-3	10	8
1-4	6	18
2-3	10	14
2-4	4	12
3-5	6	34
4-5	6	12

4. (a) Briefly discuss any five critical elements of project plan. **(8)**

(b) How can you distinguish weak matrix structure from functional structure? Provide appropriate example for each structure. **(6)**

(c) Investment and return for two different projects A and B are as follows: **(12)**

Year	Project A	Project B
0	– 1,00,000	– 1,00,000
1	25,000	35,000
2	25,000	35,000
3	30,000	30,000
4	30,000	25,000
5	35,000	22,500
6	35,000	20,000

Based on NPV and DPBP, what should be your investment decision (Either for Project A or Project B)? In which condition should you reverse your decision? Assume 10% discount rate.

(d) Consider a project requiring 80 units of products to be produced. An expert worker takes 24 hrs to complete a single product. However 32 parts need to be produced to be an expert at 75% learning rate. If the wage rate is BDT 400 per hr, by how much amount will the budget be underestimated without considering the learning effect? **(9)**

SECTION – B

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

5. (a) What is a secondary pollutant? Find below some pollutants, and identify two secondary pollutants from those.

Some pollutants: Carbon di-oxide, fuel vapor, dust; metal oxides, especially those of lead, cadmium, copper and iron; chlorofluorocarbon (CFC), hazardous air pollutants (HAPS), odors, nitrogen dioxide, ground level ozone. **(15)**

Contd P/3

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Contd ... Q. No. 5

(b) What is "Region of mixing"? Explain. **(20)**

6. (b) What was the documentation structure of the previous version (2004) of ISO 14001 EMS? What is the main difference of documentation system of the new version? Explain. **(15)**

   (b) What are the major environmental rules and regulations in Bangladesh? Describe the historical evolution of environmental rules and regulations of Bangladesh, in a flow chart. **(20)**

7. (a) State and describe the reaction for biochemical oxidation. **(15)**

   (b) How long will Kyoto Protocol remain valid? Where, when and how was it decided? **(20)**

8. (a) What is Pareto Optimal Solution in project management? Explain. **(15)**

   (b) As a regulator, often the project manager must guard and control three different kinds of assets. What are those? Explain in brief. **(20)**

Learning Rate Coefficients

Unit	70%		75%		80%		85%		90%	
Number	Unit Time	Total Time	Unit Time	Total Time	Unit Time	Total Time	Unit Time	Total Time	Unit Time	Total Time
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	0.700	1.700	0.750	1.750	0.800	1.800	0.850	1.850	0.900	1.900
3	0.568	2.268	0.634	2.384	0.702	2.502	0.773	2.623	0.846	2.746
4	0.490	2.758	0.563	2.946	0.640	3.142	0.723	3.345	0.810	3.556
5	0.437	3.195	0.513	3.459	0.596	3.738	0.686	4.031	0.783	4.339
6	0.398	3.593	0.475	3.934	0.562	4.299	0.657	4.688	0.762	5.101
7	0.367	3.960	0.446	4.380	0.534	4.834	0.634	5.322	0.744	5.845
8	0.343	4.303	0.422	4.802	0.512	5.346	0.614	5.936	0.729	6.574
9	0.323	4.626	0.402	5.204	0.493	5.839	0.597	6.533	0.716	7.290
10	0.306	4.932	0.385	5.589	0.477	6.315	0.583	7.116	0.705	7.994
11	0.291	5.223	0.370	5.958	0.462	6.777	0.570	7.686	0.695	8.689
12	0.278	5.501	0.357	6.315	0.449	7.227	0.558	8.244	0.685	9.374
13	0.267	5.769	0.345	6.660	0.438	7.665	0.548	8.792	0.677	10.052
14	0.257	6.026	0.334	6.994	0.428	8.092	0.539	9.331	0.670	10.721
15	0.248	6.274	0.325	7.319	0.418	8.511	0.530	9.861	0.663	11.384
16	0.240	6.514	0.316	7.635	0.410	8.920	0.522	10.383	0.656	12.040
17	0.233	6.747	0.309	7.944	0.402	9.322	0.515	10.898	0.650	12.690
18	0.226	6.973	0.301	8.245	0.394	9.716	0.508	11.405	0.644	13.334
19	0.220	7.192	0.295	8.540	0.388	10.104	0.501	11.907	0.639	13.974
20	0.214	7.407	0.288	8.828	0.381	10.485	0.495	12.402	0.634	14.608
21	0.209	7.615	0.283	9.111	0.375	10.860	0.490	12.892	0.630	15.237
22	0.204	7.819	0.277	9.388	0.370	11.230	0.484	13.376	0.625	15.862
23	0.199	8.018	0.272	9.660	0.364	11.594	0.479	13.856	0.621	16.483
24	0.195	8.213	0.267	9.928	0.359	11.954	0.475	14.331	0.617	17.100
25	0.191	8.404	0.263	10.191	0.355	12.309	0.470	14.801	0.613	17.713
26	0.187	8.591	0.259	10.449	0.350	12.659	0.466	15.267	0.609	18.323
27	0.183	8.774	0.255	10.704	0.346	13.005	0.462	15.728	0.606	18.929
28	0.180	8.954	0.251	10.955	0.342	13.347	0.458	16.186	0.603	19.531
29	0.177	9.131	0.247	11.202	0.338	13.685	0.454	16.640	0.599	20.131
30	0.174	9.305	0.244	11.446	0.335	14.020	0.450	17.091	0.596	20.727
31	0.171	9.476	0.240	11.686	0.331	14.351	0.447	17.538	0.593	21.320
32	0.168	9.644	0.237	11.924	0.328	14.679	0.444	17.981	0.590	21.911
33	0.165	9.809	0.234	12.158	0.324	15.003	0.441	18.422	0.588	22.498
34	0.163	9.972	0.231	12.389	0.321	15.324	0.437	18.859	0.585	23.084
35	0.160	10.133	0.229	12.618	0.318	15.643	0.434	19.294	0.583	23.666
36	0.158	10.291	0.226	12.844	0.315	15.958	0.432	19.725	0.580	24.246
37	0.156	10.447	0.223	13.067	0.313	16.271	0.429	20.154	0.578	24.824
38	0.154	10.601	0.221	13.288	0.310	16.581	0.426	20.580	0.575	25.399
39	0.152	10.753	0.219	13.507	0.307	16.888	0.424	21.004	0.573	25.972
40	0.150	10.902	0.216	13.723	0.305	17.193	0.421	21.425	0.571	26.543
41	0.148	11.050	0.214	13.937	0.303	17.496	0.419	21.844	0.569	27.111
42	0.146	11.196	0.212	14.149	0.300	17.796	0.416	22.260	0.567	27.678
43	0.144	11.341	0.210	14.359	0.298	18.094	0.414	22.674	0.565	28.243
44	0.143	11.484	0.208	14.567	0.296	18.390	0.412	23.086	0.563	28.805
45	0.141	11.625	0.206	14.773	0.294	18.684	0.410	23.496	0.561	29.366
46	0.139	11.764	0.204	14.977	0.292	18.975	0.408	23.903	0.559	29.925
47	0.138	11.902	0.202	15.180	0.290	19.265	0.405	24.309	0.557	30.482
48	0.136	12.038	0.201	15.380	0.288	19.552	0.403	24.712	0.555	31.037
49	0.135	12.173	0.199	15.579	0.286	19.838	0.402	25.113	0.553	31.590
50	0.134	12.307	0.197	15.776	0.284	20.122	0.400	25.513	0.552	32.142
51	0.132	12.439	0.196	15.972	0.282	20.404	0.398	25.911	0.550	32.692
52	0.131	12.570	0.194	16.166	0.280	20.684	0.396	26.307	0.548	33.241
53	0.130	12.700	0.192	16.358	0.279	20.963	0.394	26.701	0.547	33.787
54	0.128	12.828	0.191	16.549	0.277	21.239	0.392	27.094	0.545	34.333
55	0.127	12.955	0.190	16.739	0.275	21.515	0.391	27.484	0.544	34.877
56	0.126	13.081	0.188	16.927	0.274	21.788	0.389	27.873	0.542	35.419
57	0.125	13.206	0.187	17.114	0.272	22.060	0.388	28.261	0.541	35.960
58	0.124	13.330	0.185	17.299	0.271	22.331	0.386	28.647	0.539	36.499
59	0.123	13.453	0.184	17.483	0.269	22.600	0.384	29.031	0.538	37.037
60	0.122	13.574	0.183	17.666	0.268	22.868	0.383	29.414	0.537	37.574

L-4/T-1/IPE **Date : 30/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **IPE 419** (Computer Integrated Manufacturing)

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 are the commonly used joints available in industrial robots? For a three degree-of-freedom robot arm, how many different body-and-arm configurations are possible to manufacture? Briefly explain the most popular body-and-arm configurations for industrial robots with necessary sketches and notations. **(17)**

   (b) Draw a typical three degree-of-freedom wrist assembly. Also provide the notation of each joint and label roll, pitch and yaw in the figure. **(8)**

   (c) Robot controllers are indispensable part of industrial robots- Explain why. **(10)**

2. (a) A flexible manufacturing system (FMS) has many advantages over manually operated machine cell. Briefly explain few of these advantages. **(10)**

   (b) Classify FMS systems based on the number of machines in the system. Also discuss the changes in investment and productions rate with the change in machine numbers. Provide necessary diagram(s). **(15)**

   (c) List the names of basic components of a flexible manufacturing system (FMS). Which one of these components is responsible for interfacing one component with the other? Discuss the functions of this component briefly. **(10)**

3. (a) As a part of the design process, some form of engineering analysis often must be performed. Describe some computer aided engineering (CAE) techniques currently available with CAD software or separately. **(14)**

   (b) Process planning requires many decisions to be taken before making any part. What are these decisions? Is there any similarity between traditional process planning approach by process planner and computer aided process planning (CAPP)? Explain. **(13)**

   (c) Mention the guidelines for creating a typical route sheet and draw one with fictitious data. **(8)**

4. (a) How will the factory of the future look like? What is the ultimate goal of factory of the future concept? **(7)**

   (b) Relation between human and workplace is changing dramatically with the help of IT systems. Compare human-factory relationship in the past with in the expected relationship in future. **(10)**

   (c) Write short notes on the following business models: **(18)**

   (i) Crowdsourcing (ii) Anything-as-a-service (iii) Symbiotic ecosystem

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SECTION – B

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

5. (a) What do you understand by "Logic control system? Briefly describe different components of a PLC system with necessary sketches and explain the typical operation cycle of PLC. **(15)**

(b) Consider the fluid storage tank illustrated in Figure 5(b). When the start button X1 is depressed, this energizes the control relay C1. In turn this energizes solenoid S1, which opens a valve allowing fluid to flow into the tank. When the tank becomes full, the float switch FS closes, which opens relay C1, causing the solenoid S1 to be de-energized, thus turning off the in-flow. Switch FS also activates a second relay C2 which energize timer T1 to provide a 90 sec delay for a certain chemical reaction to occur in the tank. At the end of the delay time, the timer energizes two devices: (1) It energizes solenoid S2, which opens a valve to allow the fluid to flow out of the tank; and (2) it initiates timer T2, which waits 120 sec to allow the contents of the tank to be drained. At the end of the 120 sec, the timer breaks the current by deactivating relay C2 and de-energizes solenoid S2, thus closing the outflow valve. **(20)**

(i) Construct "Ladder logic diagram" for the existing system.

(ii) Suppose, for safety stock, the system requires additional in-flow of fluid for 60 sec after float switch FS is closed. What change do you propose in the existing system? Present your solution by drawing modified version of Figure 5(b).

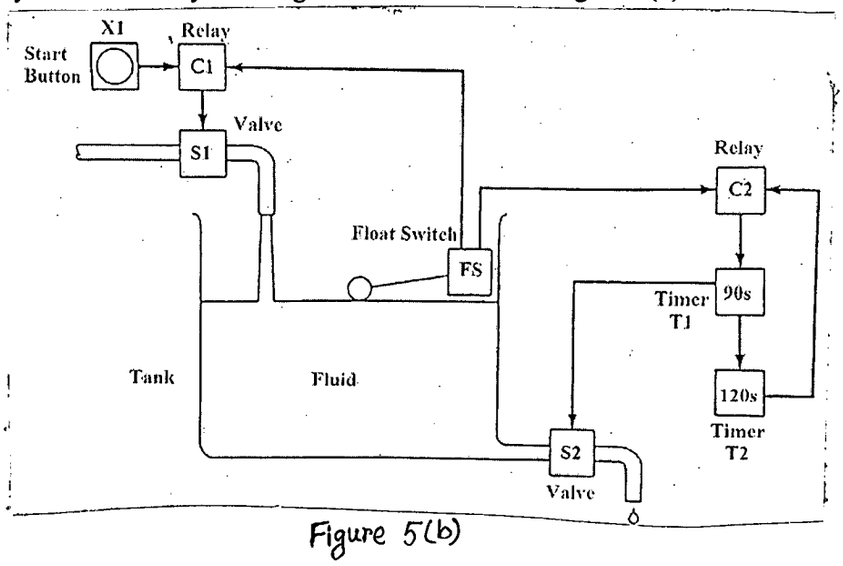

Figure 5(b)

6. (a) How can you distinguish STP cable from UTP cable? Draw labeled diagram of them and mention the benefits of each over the other. **(10)**

(b) Why "Mesh" topology is considered much secured network? **(5)**

(c) Why part classification and coding is popular though it is most time consuming grouping method? Discuss. **(5)**

(d) Identify part families and corresponding machine grouping for the following part machine matrix using rank order clustering technique: **(15)**

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Contd ... Q. No. 6(d)

Machine	Parts							
	A	B	C	D	E	F	G	H
I		1				1		
II	1			1	1			
III			1					1
IV		1				1		
V	1				1			
VI				1	1			
VII							1	1
VIII			1					1

7. (a) What are the three different codes in Opitz system for part classification and coding? Name the items included in each of the codes. **(8)**

   (b) Discuss the advantages and disadvantages of "Token Passing" access control method. **(7)**

   (c) Discuss briefly the working principle of scanner in a bar code reader. **(5)**

   (d) What is Open Systems Interconnection model (OSI model)? Write down name of the stages involved in this model and discuss briefly about them. **(15)**

8. (a) "Wire guided" and "Line guided" AVGs are not appropriate in highly flexible manufacturing system – Why? **(5)**

   (b) Illustrate CSMA/CD access control method with the help of a flowchart. **(12)**

   (c) Briefly discuss three criteria which need to be considered in designing material handling system. **(10)**

   (d) Discuss different types of communication network with application area. **(8)**
