

The figures in the margin indicate full marks.

Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Shigley's Mechanical Engineering Design book will be supplied. Assume appropriate value for any missing data.

1. (a) What do you understand by *conjugate action* of gear? Define Interference in terms of conjugate action. (10)
- (b) Design a straight-bevel gear mesh that satisfies the following requirements. (25)
 - (i) Shaft centerlines intersecting perpendicularly.
 - (ii) Delivering 10 hp at 1150 rev/min
 - (iii) Gear ratio of 4:1
 - (iv) Temperature at the place of application max. 400°F,
 - (v) Design factor of 3.
 - (vi) Loading condition: Light shock-medium shock.

2. (a) Prove that *Time to Failure* for a time dependent failure model follows the Weibull distribution. (10)
- (b) A steel spur pinion has a diametral pitch of 6 teeth/in, 22 full-depth teeth, and a 20° pressure angle. The pinion runs at a speed of 1200 rev/min and transmits 15 hp to a 60 tooth gear. If the face width is 2 in, estimate the pinion bending stress. (10)
- (c) Find the reliability of the system shown in Fig. Q. 2(c) for 3000 *hours*. The constituent components' failure related data are presented in the following table. (15)

Components	A	B	C
Failure Criterion	Time dependent failure with Scale Parameter = 16000 hour and Shape Parameter = $\frac{1}{3}$	Fatigue wear out having a lognormal distribution with a mean and COV of 5100 hr and 0.2, respectively.	Constant failure rate with 1.71×10^{-5} failures per hour.

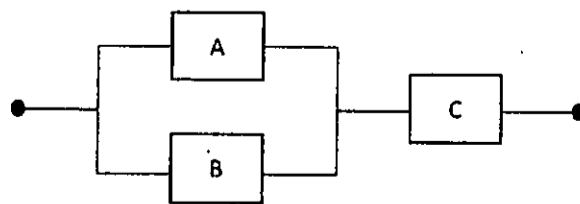


Figure Q2(c)

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3. (a) For the following figure, Fig. Q. 3(a), on which shoe do you think self-braking is a threat? Support your answer with a legitimate reason. (5)

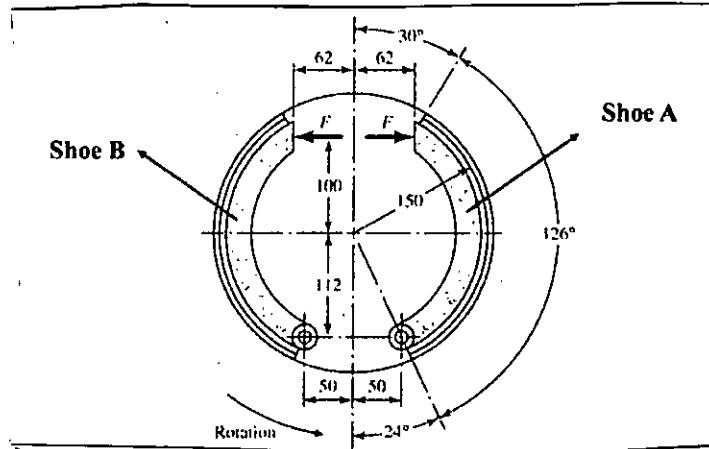


Figure Q3(a)

- (b) A good brake design will concentrate as much frictional material as possible near hinge point. Do you agree? Explain your answer briefly. (10)

- (c) Suppose your vehicle runs on a Frictional-Contact mult-disk plate clutch that has $D = 6.5$ in, $d = 4$ in, a coefficient of friction of 0.24, and the limiting pressure of 120 psi.

There are six planes of sliding present. (20)

- (i) Estimate the limiting axial force F and the torque T by both uniform pressure and uniform wear models.
 (ii) Let the inner diameter of the plate be a variable. Complete the following table using uniform wear model and comment on your vehicle's clutching capacity.

d, in	2	3	4	5	6
T	?	?	?	?	7

4. (a) Explain reliability for the following static models with necessary figures and mathematical expressions. (20)

- (i) Random Stress and Constant Strength
 (ii) Constant Stress and Random Strength
 (iii) Random Stress and Random Strength

- (b) A hot rolled steel has a yield strength $S_y \sim N(100, 15)$ kpsi. Estimate the static reliability of the steel if it has to sustain maximum and minimum principal stresses $\sigma_1 \sim N(80, 10)$ kpsi and $\sigma_2 \sim N(10, 2.5)$ kpsi. (15)

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SECTION – B

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

Assume relevant value for any missing data. Shigley’s Mechanical Engineering Design book will be provided.

5. (a) A 16-tooth pinion drives the double-reduction spur-gear train in the figure Q. 5. All gears have 25° pressure angles. The pinion rotates ccw at 1200 rev/min and transmits power to the gear train. The shaft has not yet been designed, but the free bodies have been generated. The shaft speeds are 1200 rev/min, 240 rev/min, and 80 rev/min. A bearing study is commencing with a 10-kh life and a gearbox bearing ensemble reliability of 0.99, assuming distribution data from manufacturer 2 in Table 11-6. An application factor of 1.2 is appropriate. For each shaft, specify a matched pair of 02-series cylindrical roller bearings from Table 11-3.

(20)

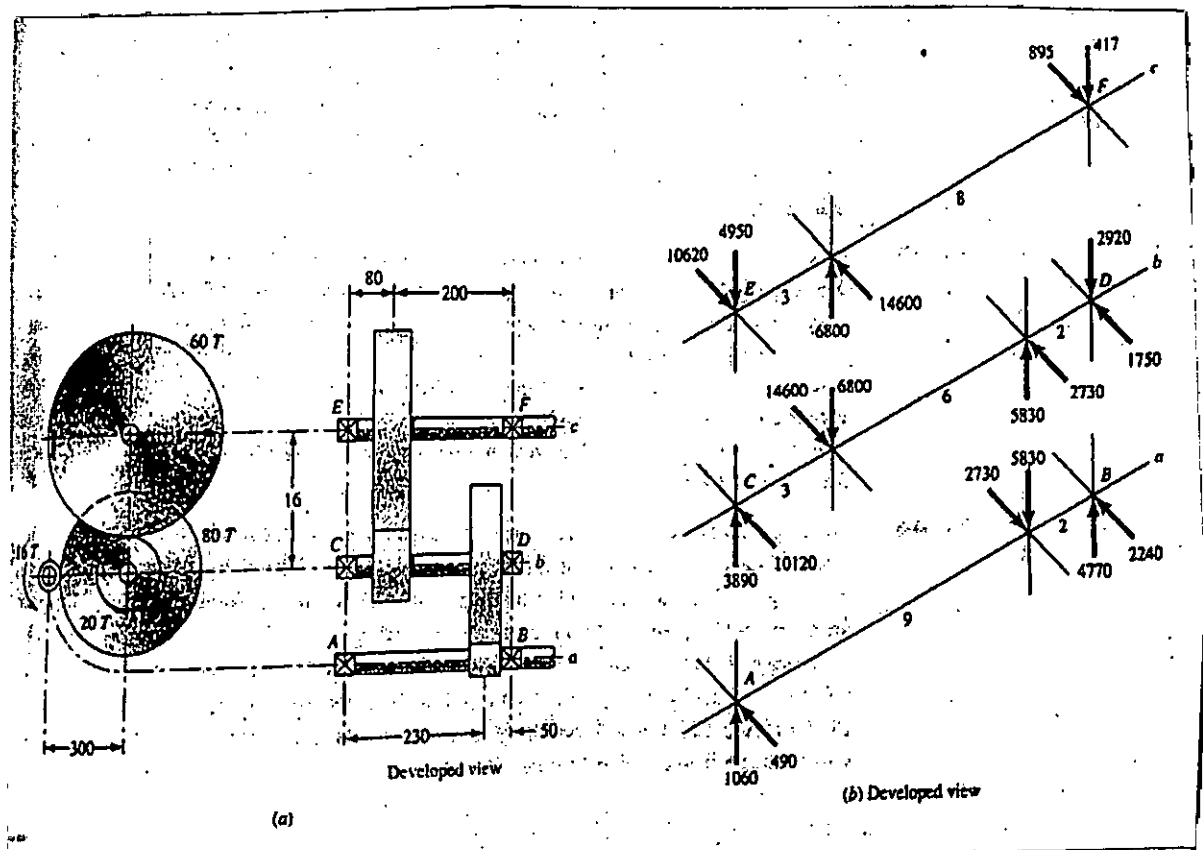


Figure Q5: (a) Drive detail, (b) Force analysis on shafts. Forces in Newtons. Linear dimensions in millimeters.

- (b) Define Life Cycle Thinking for implementing design for environment. What are the necessary steps for conducting a Life Cycle Assessment? Explain the guidelines for material selection for incorporating DFE.

(10)

- (c) A voltage regulator may be obtained from two vendors. Vendor A’s regulator costs \$150 and Vendor B’s regulator costs \$200. Vendor A’s is less reliable with a MTTF of 1800 days while Vendor B’s MTTF is 2600 days, Vendor A’s regulator has a more modular design and is therefore easier to replace with a MTTR of 4 hr while Vendor B’s regulator takes 6 hr to replace. If a failed regulator must be replaced at its unit cost, which product should be used? The labor rate \$45 per hour and the design life of the regulator is considered to be 10 yrs.

(5)

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6. (a) A gear reduction unit uses the countershaft shown in the figure Q. 6(a). Gear A receives power from another gear with the transmitted force F_A applied at the 20° pressure angle as shown. The power is transmitted through the shaft and delivered through gear B through a transmitted force F_B at the pressure angle shown. For the countershaft in the figure below, assume the gear ratio from gear B to its mating gear is 5 to 1.

(10)

- (i) Determine the minimum number of teeth that can be used on gear B without an interference problem in the teeth.
- (ii) Using the number of teeth from part (i) what module is required to also achieve the given 300-mm pitch diameter?
- (iii) Suppose the 20° pressure angle for gear A is exchanged for a gear with 25° pressure angle, while maintaining the same pitch diameters and module. Determine the new forces F_A and F_B if the same power is to be transmitted.

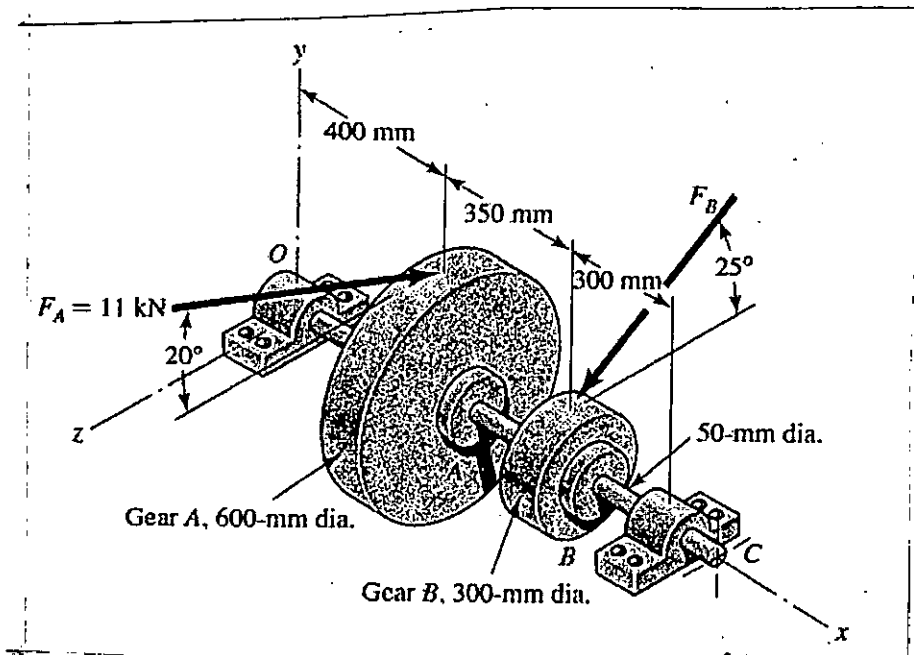


Figure Q6(a)

(b) A 64 mm X 64 mm sleeve bearing uses grade 20 lubricant. The axial-groove sump has a steady-state temperature of 43°C . The shaft journal has a diameter of 63.5 mm with a unilateral tolerance of -0.025 mm. The journal speed is 1120 rev/min and the radial load is 5.34 KN. Estimate the following:

(15)

- (i) The magnitude and location of the minimum oil-film thickness.
- (ii) The power loss rate.
- (iii) Both the total and side oil-flow rates.
- (iv) The maximum oil-film pressure and its angular location.
- (v) The average temperature of the side flow.
- (vi) The oil temperature at the terminating position of the oil film.

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Contd ... Q. No. 6

(c) Explain with necessary diagram, the relationship between bearing characteristic and coefficient of friction in the case of unstable lubrication. (10)

7. (a) The 24T 6-pitch 20° pinion 2 shown in the figure Q. 7(a) rotates clockwise at 1000 rev/min and is driven at a power of 25 hp. Gears 4, 5, and 6 have 24, 36 and 144 teeth, respectively. What torque can arm 3 deliver to its output shaft? Draw free-body diagrams of the arm and of each gear and show all forces that act upon them. (20)

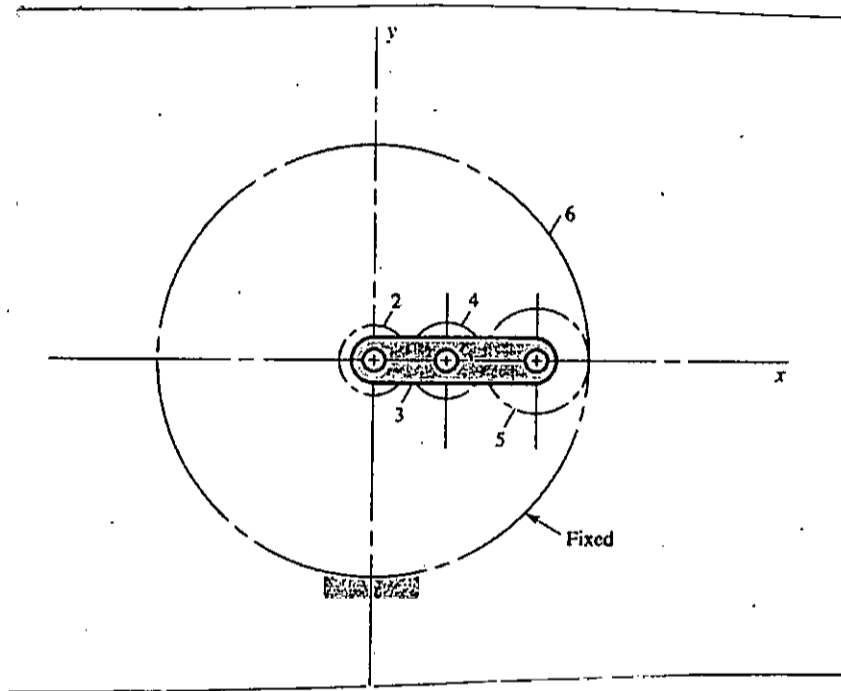


Figure Q7(a)

(b) How was design for maintainability incorporated through the design structure, material selection and repair system of Boeing 787 Dreamliner? Explain with necessary examples. (10)

(c) Prove that Sommerfeld number is dimensionless. (5)

8. (a) A torque $T=100 \text{ Nm}$ is applied to the shaft EFG, which is running at constant speed and contains gear F. Gear F transmits torque to shaft ABCD through gear C, which drives the chain sprocket at B, transmitting a force P as shown in figure Q. 8(a). Sprocket B, gear C, and gear F have pitch diameters of $a = 150$, $b = 250$, and $c = 125 \text{ mm}$, respectively. The contact force between the gears is transmitted through the pressure angle of 20° . No frictional losses are assumed. The bearings at A, D, E, and G are considered to be simple supports. A motor providing 2 kW is to operate at 191 rev/min . A gear unit is needed to reduce the motor speed by half to drive a chain sprocket. (20)

CE 441

Contd ... Q. No. 8

- (i) Specify appropriate numbers of teeth on gears F and C to minimize the size while avoiding the interference problem in the teeth.
- (ii) Assuming an initial guess of 125-mm pitch diameter for gear F, what is the module that should be used for the stress analysis of the gear teeth?
- (iii) Calculate the input torque applied to shaft EFG.
- (iv) Calculate the magnitudes of the radial, tangential, and total forces transmitted between gears F and C.

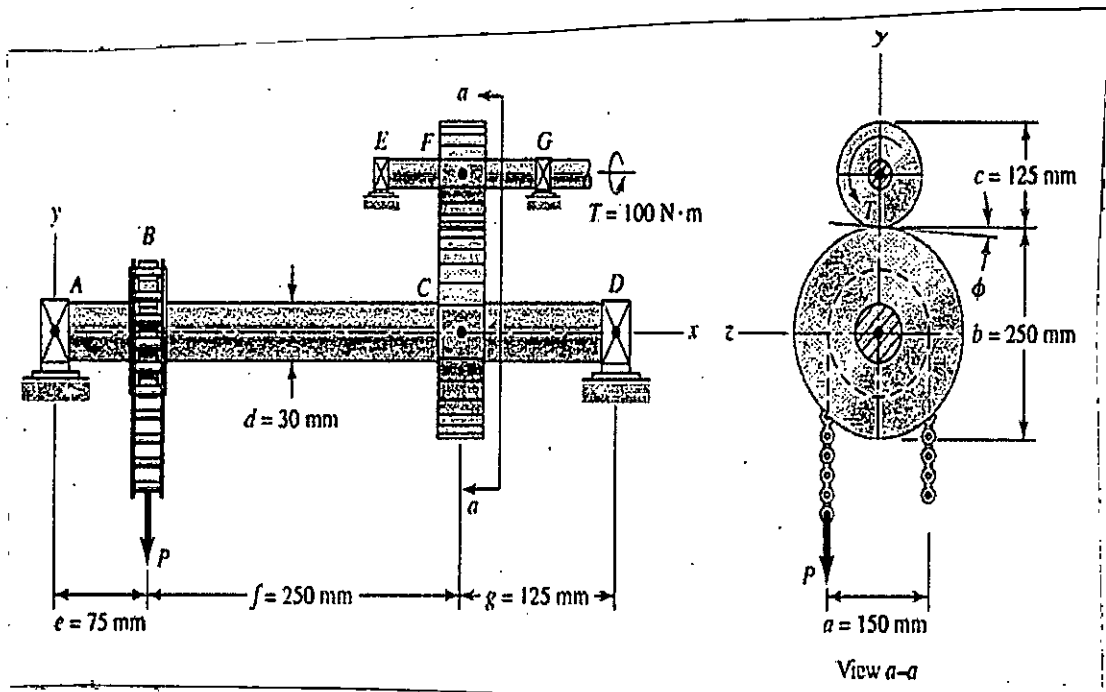


Figure Q8(a)

- (b) Describe the guidelines for accessibility from the perspective of assembly. Make a hierarchy of components from most preferred to least preferred in case of accessibility. Describe the scope of modular design and interchangeability in the design of a rickshaw.

(3+3+9)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

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

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Name four different monitoring policies with example for each. (8)
- (b) Responsibility, Authority and Accountability should be simultaneous for successful project implementation – justify. (7)
- (c) For the following activity table, find different possible crash times and corresponding costs for the project: (20)

Activity	Predecessor	Duration (day)		Cost (USD)	
		Normal	Crash	Normal	Crash
a	----	4	2	40	80
b	a	5	4	30	50
c	a	3	3	40	40
d	a, b	5	2	60	120
e	a, c	4	4	50	50
f	d, c	3	1	40	90

2. (a) Briefly explain the required characteristics if you want to be a candidate for the post of a project manager. (12)
- (b) WBS is preferred to execute large projects – why? Briefly discuss the four conditions of WBS. (8)
- (c) For the following activity table, obtain a schedule to keep the manpower requirement in level: (15)

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

IPE 403

3. (a) Name four requirements of an effective plan. Discuss importance for each of those requirements. (8)
- (b) Iterative budget is better than both top-down and bottom-up budgets – justify. For unresolved negotiation, what should be our approach about the final budget? (10)
- (c) For the following task table, draw the network diagram, calculate total duration of the project, find the critical path and calculate free and total slack for each activity: (17)

Task	Successor	Duration (days)
A	L, B	3
B	I	4
C	-	5
D	A, J	5
E	J	4
F	I	4
G	A	3
H	-	3
I	C, K, H	4
J	B, F	3
K	-	5
L	I	2

4. (a) Briefly explain the three basic areas for effective negotiation. (10)
- (b) Compare the responsibilities of a project manager and a functional manager for heavy and weak matrix structure. (7)
- (c) How can you distinguish economic evaluation from financial evaluation for appraising bridge construction project? (6)
- (d) Based on Net present value and Discounted payback period, what should be your investment decision (Project A or B)? Why? In which condition should you reverse your decision? Discount rate is 10%. (12)

Year	Project A	Project B
0	-10,00,000	-10,00,000
1	250,000	350,000
2	250,000	350,000
3	300,000	300,000
4	300,000	250,000
5	350,000	225,000
6	350,000	200,000

IPE 403

SECTION – B

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

5. (a) What are the three main differences between Kyoto Protocol and Paris Agreement? Explain. (20)
 - (b) What is SCOR Model? When and for what is it used? (15)
 6. (a) What are ICTPs? Define and explain with example. (20)
 - (b) What are Wet and Dry Depositions? (15)
 7. (a) Describe, using a flow chart, complete certification process for Orange A category of industry. (20)
 - (b) Write down in brief the documentation systems of ISO14000 EMS: 2004 and 2015 versions. (15)
 8. (a) What is Project Life Cycle? Explain with necessary diagrams. (20)
 - (b) State some attributes that characterize projects. (15)
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SECTION – A

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

1. (a) Explain different means of measuring physiological strain with their relative advantages and disadvantages. (15)
(b) Write down the NIOSH lifting equation. How does this equation guide to prevent lifting injuries? Explain. (10)
(c) How can you design a job to reduce the risk of manual material handling overexertion? (10)
2. (a) Write in details about the lighting design considerations for a typical production floor. (15)
(b) Briefly describe the different types of visual defects. (10)
(c) Why is color selection crucial for visual comfort of workers in a workplace? Mention different guidelines for color selection. (10)
3. (a) Write in details about the consequences of not maintaining a straight wrist during using hand tools. (15)
(b) Mention the symptoms and control measures for HAVS. (10)
(c) How can you design a hand tool to avoid the risk of trigger finger? (10)
4. (a) What do you understand by workspace envelope? Describe the variables that limit the workspace envelope for standing personnel. (15)
(b) How can you ensure adjustability and reduce postural fixity during seat design? (10)
(c) Differentiate between work surface height and working height. How should the work surface height vary with types of task performed? (10)

SECTION – B

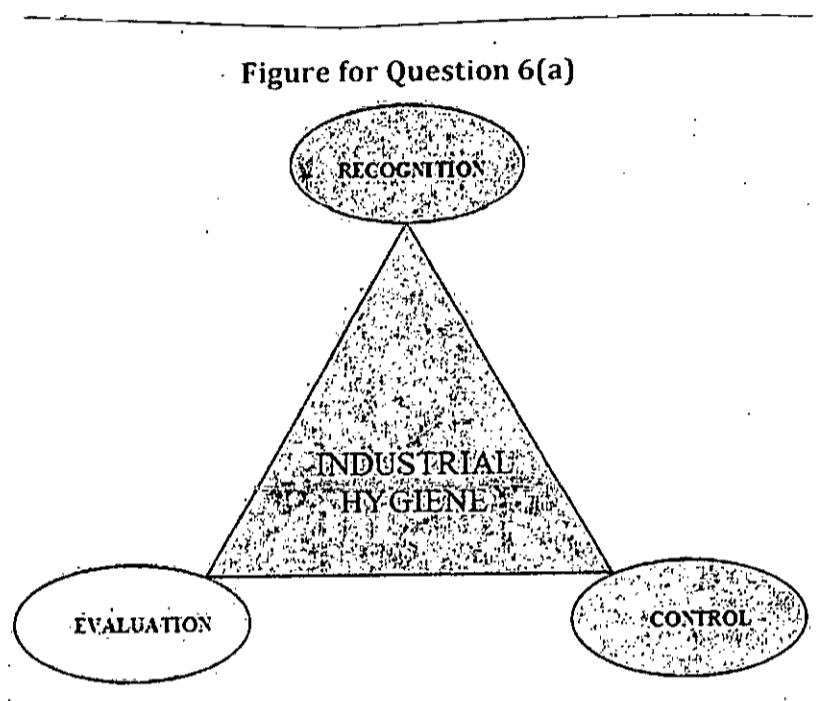
There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable values for missing data, if any.

5. (a) How can you distinguish strategic aspects of occupational health and safety management (OHSM) from operational and tactical aspects of OHSM? To support your answer, link the strategic, operational, and tactical aspects of OHSM to practical examples as you have gathered from your industrial internship experience. (20)
(b) “Controlling the energy involved or changing the structures that energy could damage can prevent accidents” – Do you agree or disagree with this statement? Justify your answer with practical examples. (15)

IPE 407

6. (a) Suppose you are working as an industrial hygienist of a manufacturing firm. The top management of the firm is recently taking necessary steps to ensure industrial hygiene at the workplace. They refer you the figure for Question 6(a) and ask you to examine the current level of the practices of industrial hygiene at the workplace. Detail your answer to respond to the top management regarding industrial hygiene practices. To simplify your analysis, you can anonymously reference the manufacturing firm you had visited during your industrial internship program. (20)



- (b) Classify the types of fire extinguishers with their intended use. (8)
- (c) How does ISO 45001 help firms to achieve the desired outcomes of their occupational health and safety management systems? (7)
7. (a) In which phase of a "System Life Cycle" can you apply the "Fault Tree Analysis" technique to example the system safety and reliability? How? Detail the steps using examples. (20)
- (b) Occupational Safety and Health Administration (OSHA) suggests that two standard forms (Form 300 and Form 300A) be used for recording work-related injuries and illness at workplace. With practical examples from your industrial internship experience, distinguish OSHA's Form 300 from OSHA's Form 300A. (15)
8. (a) How can you reduce worker exposure to noise hazard through engineering and administrative controls? Illustrate those with examples. (20)
- (b) What is heat acclimatization? Briefly describe different types of heat illness. (15)
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

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 is an industrial robot? Briefly explain different applications of industrial robots that can significantly improve the productivity and product quality in Bangladesh. (7)
- (b) Discuss common joints used in industrial robots with necessary sketches. Also draw and explain the popular body-and-arm configurations of industrial robots with their notations. (15)
- (c) With a block diagram, briefly describe hierarchical control structure of a robot controller. Compare playback with point-to-point, playback with continuous path control and intelligent control systems. (13)

2. (a) What do you understand by discrete process control systems. What type of control systems are used in home air conditioner and washing machines? Briefly explain. (8)
- (b) With a neat sketch explain the working principle of a typical magnetic relay (5pin). Draw the wiring diagram for a system that will use a relay to turn on a bulb by battery power when there is no electricity and turn off the bulb when electricity is available. You can use a 5v mobile charger to sense the availability of the electricity and energize the relay. Provide the ladder logic diagram for the system. (15)
- (c) List the name of symbols used in ladder logic diagram shown in Figure Q-2(c) and write the functions of these components. Also describe the working principles of the system represented by the diagram. (12)

3. (a) What are the capabilities that a manufacturing system must possess to be flexible? Briefly explain. How many categories of FMS systems are there based on the number of machining centers available in the system? For the manufacturing system shown in Figure Q-3(a), write the names of different parts labelled with alphabets A to J. Which category does the system belong to? Write the name(s) of flexibility test(s) the system will pass? Explain your answer. (20)
- (b) What are the common layouts found in FMS systems? Explain with necessary sketches. Discuss the differences between primary handling systems and secondary handling systems in terms of their location and functionalities. (15)

IPE 419

4. (a) What are the common forms of engineering analysis performed after designing a product? Explain each of them. What is the difference between virtual reality and augmented reality? Why is virtual prototyping becoming more popular for some specific type of products now a days? Discuss in short. (20)
- (b) How does a retrieval CAPP system differ from a generative CAPP system? Discuss generative CAPP system briefly. (15)

SECTION – B

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

5. (a) How can you interconnect four different levels of hierarchy for proper communication? Describe the role of each level. (12)
- (b) What are the basic functions of an AGV? (5)
- (c) What are the primary requirements for designing a material handling system? Mention the importance of each of the requirements. (12)
- (d) Mention the application areas of Cellular manufacturing in Bangladesh. (6)
6. (a) WiMAX covers much larger area compared to Wi-Fi – still WiMAX technology failed in Bangladesh. Why? (6)
- (b) What are the three different codes in Opitz system? Name the elements to be covered by each of the codes. (10)
- (c) Briefly explain the working principle of fiber optic system for transmitting data from source to destination. (7)
- (d) Name six different categories of automatic data capture with appropriate examples. (12)
7. (a) How can you distinguish UTP from STP twisted pair cable? Which one of these is superior and why? (6)
- (b) Briefly describe the working principles of Wire-guided vehicle and Line-guided AGVs. How do the AGVs follow the required paths at junction points? (9)
- (c) Prepare the PFA chart from the following machine-part matrix: (20)

M/Cs	A	B	C	D	E	F	G	H	I	J
1	1						1			
2		1				1			1	
3			1						1	1
4					1			1		
5	1			1			1			
6					1	1		1		
7		1	1						1	1
8	1		1	1						

IPE 419

- 8. (a) What are the differences between third and fourth industrial revolution? (10)
- (b) What do you understand by “cyber physical systems”? Explain how these systems can help in creating factories of the future. (10)
- (c) Sometimes the convergence and application of industrial technologies is referred to Industry 4.0. What are those technologies? Briefly discuss each of these technologies. (15)

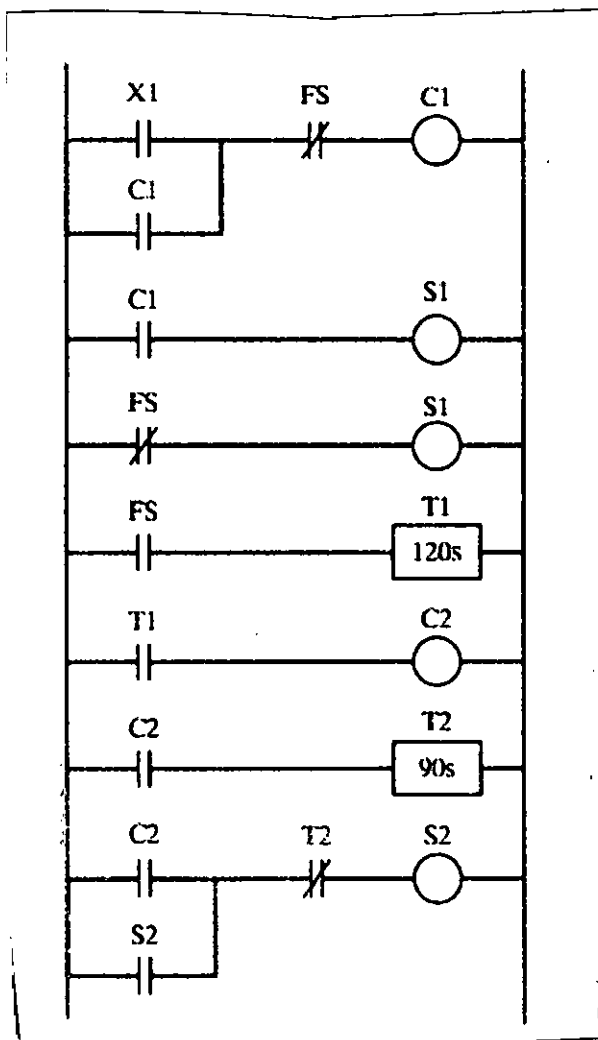


Figure Q-2(c)

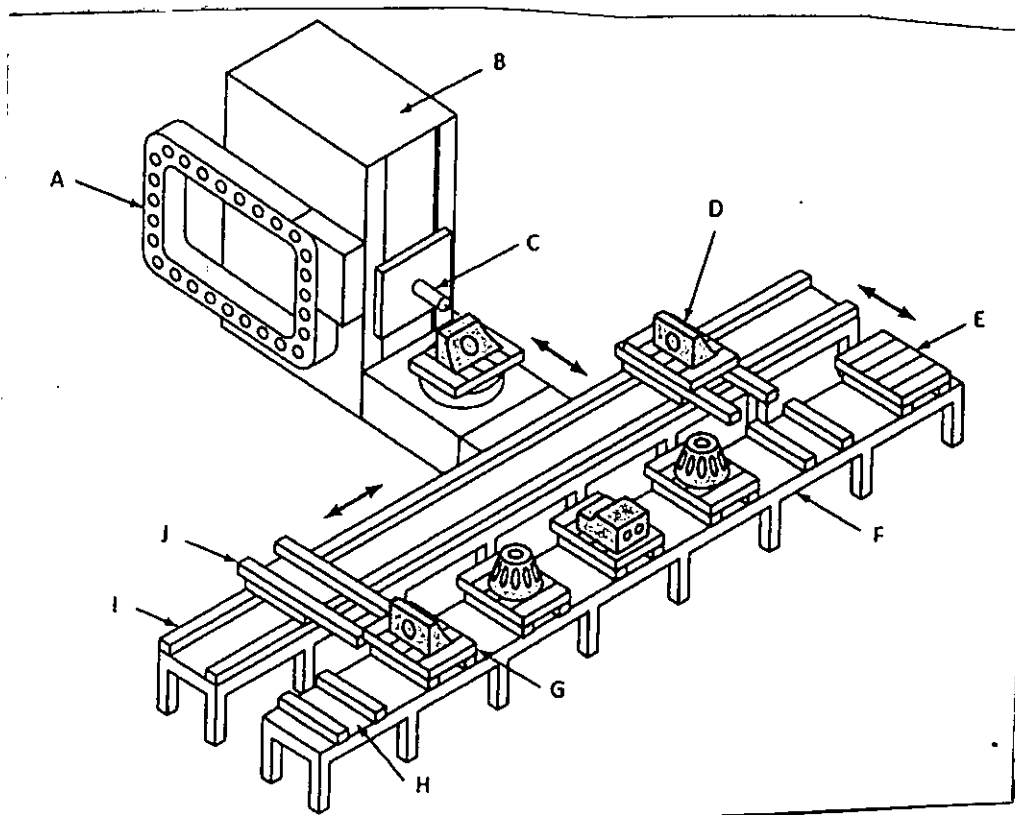


Figure Q-3(a)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

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 – AThere are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Explain how Gateway changed their strategy of distribution of PCs and hardware over time. (15)
- (b) Which distribution network is suitable for grocery business, taking into account Webvan and Peapod? Draw necessary distribution network diagram. (20)
2. (a) Describe the impact of online sales to sell physical books and e-books. (15)
- (b) What is a value chain in a company? Describe related strategies. (20)
3. (a) Describe “Pricing obstacle” against coordination in a supply chain. (15)
- (b) What transportation network does Home Depot follow in the US market? Explain with right diagram. (20)
4. (a) What are the major differences between 3PL and 4PL logistics providers? (15)
- (b) Asian Bicycle Corporation (ABC) Ltd. requires to buy ring bells from a supplier, for which total annual inventory cost is 1,25,00 \$/year, without taking into account annual ordering cost. Annual demand of ring bell is 60,000 bells.
Currently, ABC is considering an alternative new supplier for ring bells. The new supplier proposes that the purchasing lot size should be one carton, filled with 3000 bells, at a purchasing price of 6000 \$/carton. The company works for 300 days per year. There is uncertainty in demand, as well as uncertainty in lead time. Average purchasing lead time is 3 days, standard deviation of demand is 50 pieces, and standard deviation of lead time is 1 day. Holding cost is 30% of the value of stock. If the CSL value is 95%, then is the new supplier better in terms of annual inventory cost? (20)

SECTION – BThere are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable values for missing data, if any.

z-score table is attached.

5. (a) Swell Productions is sponsoring an outdoor conclave for owners of collectible and classic Fords. The concession stand in the T-Bird area will sell clothing such as T-shirts and official Thunderbird racing jerseys. Jerseys are purchased from Columbia Products for \$40 each and are sold during the event for \$75 each.

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Contd...Q. No. 5(a)

If any are left over, they can be returned to Columbia for a refund of \$30 each. Jersey sales depend on the weather, attendance, and other variables. The following table shows the probability of various sales quantities. How many jerseys should Swell Productions order from Columbia for this one-time event?

(20)

Table for Question 5(a).

Sales Quantity	Probability	Quantity Sales	Probability
100	0.05	400	0.34
200	0.11	500	0.11
300	0.34	600	0.05

(b) The Office Supply Shop estimates that the average demand for a popular ball-point pen in 12,000 pens per week with a standard deviation of 3,000 pens. The current inventory policy call for replenishment orders of 156,000 pens. The average lead time from the distributor is 5 weeks, with a standard deviation of 2 weeks. If management wants a 95 percent cycle-service level, what should the reorder point be?

(15)

6. (a) SparesRUs, an auto parts retailer, must decide on the order size for a 20 year-old model of brakes. The manufacturer plans to discontinue production of these brakes after this last production run. SparesRUs has forecast remaining demand for the brakes to be normally distributed, with a mean of 150 and a standard deviation of 40. The brakes have a retails price of \$200. Any unsold brakes are useless and have no salvage value. The manufacturer plans to sell each brake for \$50 if the order is for less than 200 brakes and \$45 if the order is for at least 200 brakes. How many brakes should SparesRUs order?

(20)

(b) Weekly demand for handbags at Liverpool, a Mexican departmental store chain, is normally distributed with a mean of 3,000 and a standard deviation of 1,000. The replenishment lead time from the supplier is 4 weeks. Liverpool uses a periodic review policy under which it reorders handbags every 12 weeks. It currently uses an order-up-to level of 50,000. What is the average order size? How much safety inventory of handbags does Liverpool carry? What CSL does it achieve? What order up to level should it use if it wants a CSL of 99 percent?

(15)

7. (a) Epson produces printers in its Taiwan factory for sale in Europe. Printers sold in different countries differ in terms of the power outlet as well as the language of the manuals. Currently, Epson assembles and packs printers for sale in individual countries. The distribution of weekly demand in different countries is normally distributed, with means and standard deviations as shown in **Table for Question 7(a)**. Assume demand in different countries to be independent. Given that the lead time from the Taiwan factory is eight weeks, how much safety inventory does Epson require in Europe if it targets a CSL of 95 percent?

IPE 451

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

Epson decides to build a central DC in Europe. It will ship base printers (without power supply) to the DC. When an order is received, the DC will assemble power supplies, add manuals, and ship the printers to the appropriate country. The base printers are still to be manufactured in Taiwan with a lead time of eight weeks. How much saving of safety inventory can Epson expect as a result? (20)

Table for Question 7(a).

Country	Mean Demand	Standard Deviation
France	3,000	2,000
Germany	4,000	2,200
Spain	2,000	1,400
Italy	2,500	1,600
Portugal	1,000	800
UK	4,000	2,400

(b) Dominick's supermarket chain sells Nut Flakes, a popular cereal manufactured by the Tastee cereal company. Demand for Nut Flakes is 1,000 boxes per week. Dominick's has a holding cost of 25 percent and incurs a fixed trucking cost of \$200 for each replenishment order it places with Tastee. Given that Tastee normally charges \$2 per box of Nut Flakes, how much should Dominick's order in each replenishment lot? Tastee runs a trade promotion for a month, lowering the price of Nut Flakes to \$1.80. How much should Dominick's order, given the short-term price reduction? (15)

8. (a) What do you mean by 'supply chain macro processes' in a firm? Justify your answer with examples and an appropriate figure. (20)

(b) Discuss the push/pull view of a supply chain with necessary figures. (15)
