



**SASTRA**

DEEMED TO BE UNIVERSITY

ESTD 1914



School of Computing

End Semester Exam – May 2024

Course Code: CSE314R01

Course Name: Software Engineering

Practices

Duration: 180 minutes Max Marks: 100

CSE 215

**Answer the following question.**

Q1. Assume an application for better delivery of Citizen Services in the village through computerization of applications like Online Patta (land authority) Transfer System (OPTS), and Online Petition Monitoring System (OPMS).

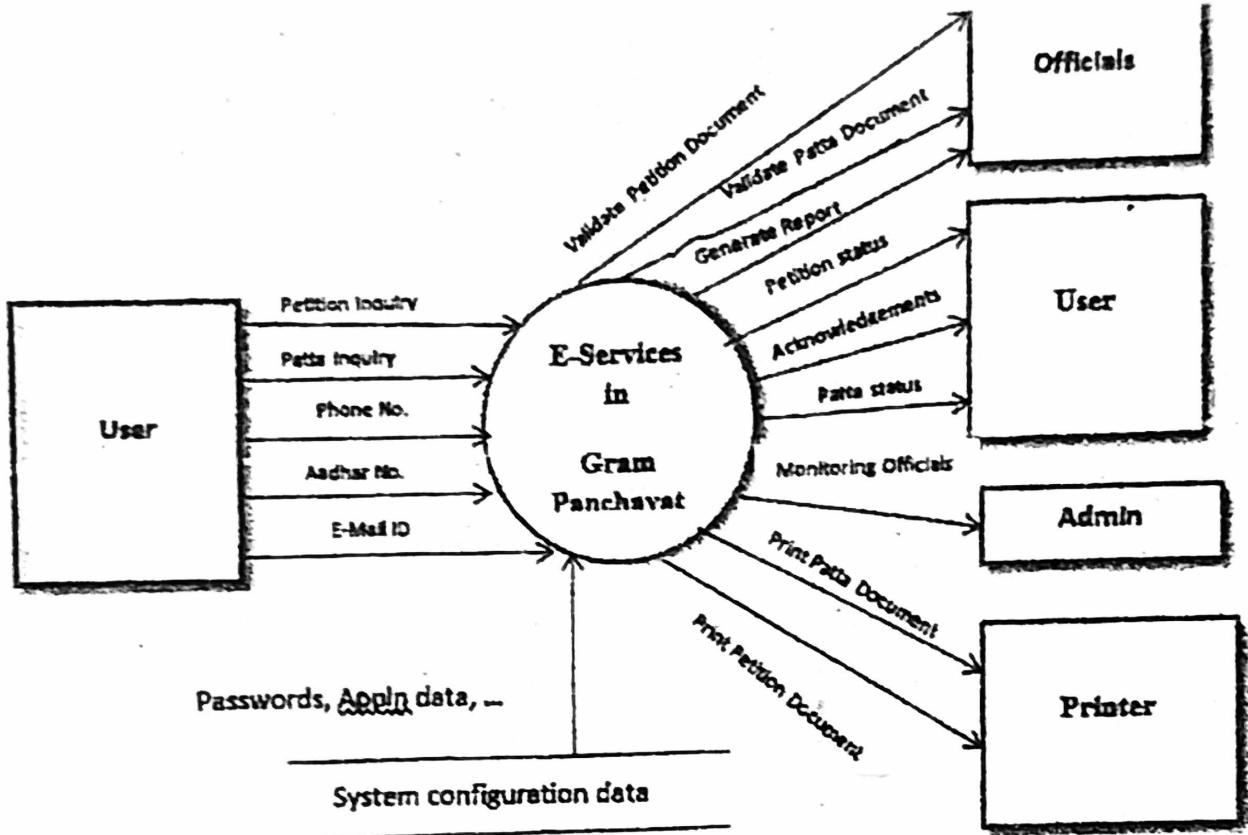
**OPTS:** Petition Processing Portal (E-district GDP) is an integral part of the district administration and the related departments in their day – to – day office work. OPMS is the customized version of E – district GDP for accepting applications and has the facility to record the petitions of different types of applications such as,

- Birth Certificate
- Death Certificate
- Community Certificate
- Pan Card

This service facilitates the public to submit petitions of their grievance and officers to process the applications and the senior officers to monitor and review the application processing.

**OPMS:** This service enables the Online Patta Transfer for land parcels with options like ISD (Including Sub – Divisions) and NISD (Not Including Sub – Divisions). Status of each stage is intimated to the applicant via SMS and Patta Transfer order is generated in the system which is secured with 2D-Barcode. This proposed system provides transparency and integrity of data. These services enable people to track and view the status of the application at Collectorate Counters, Common Service Centres, ANYTIME ANYWHERE SYSTEMS. These services can be viewed and updated by the staff of the Gram Panchayat. The mutation that happened at registration department is reflected instantaneously through web services. These services are citizen centric and web enabled services using Open-Source Technologies. The project will be provided with new features every month to satisfy the customer requirements.

- i) a. Having understood the given scenario, prepare the software requirement specification. (10)  
b. Identify the appropriate process model for the given scenario and explain the model with proper justification. (15)
- ii) a. Identify the potential classes which satisfies the criteria and draw an appropriate class diagram for the given scenario (15)  
b. Consider the following data flow diagram:



Identify the information domain values and estimate the total FP by assuming that  $\Sigma f_i = 50$  with simple complexity. (10)

- iii) a. Refine the analysis classes and elaborate the set of design classes (10)
  - b. Draw user interface design for online petition monitoring system and discuss the component level design steps for the given scenario. (15)
- iv) a. Consider the following conditions for different modules:

**Value conditions for *adminLogin*:**

- Aadhar Number should be valid unique 12-digit number
- E-Mail id should be valid one and ends with "@gmail.com"
- Taluk Code should be valid unique 6-digit code.

**Value conditions for *addOfficials*:**

- Valid TNPSC GROUP IV marksheets should be attached
- AGE limit should be 21-42
- Experience in years should be in the range of 0-20.

**Value conditions for *removeOfficials*:**

- Official ID should be valid unique 5-digit alphanumeric code.

Design test cases to verify these modules using boundary value analysis and equivalence partitioning for the given input domain. (15)

- b. How will you perform partition testing and multiple class testing for the given problem statement? (10)

**SASTRA DEEMED UNIVERSITY**  
(A University under section 3 of the UGC Act, 1956)

**End Semester Examinations**

**May 2024**

**Course Code: ENG212**

**Course: BUSINESS COMMUNICATION & VALUE SCIENCE-III**

**QP No. :U074-4**

**Duration: 3 hours**

**Max. Marks:100**

**PART - A**

**Answer any FOUR of the following questions in about 300 words.**

**$4 \times 20 = 80$  Marks**

1. Science is the corner stone in the development of nation- Elucidate.
2. Produce a user manual for any gadget, you have recently purchased. Include Logo, Caption, safety guidelines, functions and capabilities of the product, variants, instructions for installation, use & troubleshooting and warranty statement.
3. Analyse a SWOT to achieve your goals. Identify your strengths and weaknesses, leverage opportunities and counteract the threats/Challenges in the Business Era.
4. Elevate the thoughts of VUCA to VUCA 2.0 in the perspective of startups.
5. a) Discuss on the application of artificial intelligence in everyday life.  
b) Motivation causes you to act in a way that gets you closer to your goals - substantiate with adequate example and pictorial representation.

6. Draft a Feasibility Report to start a naturopathy product manufacturing unit. Naturopathy products are not harmful to the body, these products are made from organic and all-natural ingredients. They also come in recyclable compostable or biodegradable packaging. Your report should contain- terms of reference, work done, findings, recommendations and conclusion.

### **PART - B**

**Answer the following question in about 400 words.**

**$1 \times 20 = 20$  Marks**

7. Design your University in 2035 anticipating the future, embedded with modern digital technology.

\*\*

**SASTRA DEEMED UNIVERSITY**  
(A University under section 3 of the UGC Act, 1956)

**End Semester Examinations**

**May 2024**

**Course Code: MAT330R01**

**Course: OPERATIONS RESEARCH**

**QP No. :U365-4**

**Duration: 3 hours**

**Max. Marks:100**

**PART - A**

**Answer all the questions**

**10 x 2 = 20 Marks**

1. Write the procedure for forming an LPP.

2. Use graphical method to solve the following LPP

*Maximize Z = 2x<sub>1</sub> + 4x<sub>2</sub>* subject to the constraints:

$$x_1 + 2x_2 \leq 5,$$

$$x_1 + x_2 \leq 4, \quad \text{and}$$

$$x_1, x_2 \geq 0.$$

3. Define Pseudo-optimal solution.

4. Write important steps for Vogel's Approximation method (VAM).

5. Define degenerate and non-degenerate in transportation problems.

6. Give any two differences of the Transportation problem and the Assignment Problem.

7. The annual demand for an item is 3200 units. The unit cost is Rs. 6/- and inventory carrying charges 25% per annum. If the cost of one procurement is Rs.150/. Determine Economic order quantity.

800

8. What is the minimum average cost of purchasing a model with no shortage?
9. Which of the following is correct in deterministic queueing model,
- arrival rate is known and the service time is also certain.
  - arrival rate must not exceed the service rate.
  - the service rate and the service time are reciprocals of each other.
  - if the arrivals occur according to a Poisson distribution, the inter-arrival times would be exponentially distributed.
10. The cost of providing service in a queueing system decreases with
- decreased arrival rate.
  - increased arrival rate
  - decreased average waiting time.
  - None of the above

### PART - B

Answer all the questions

**4 x 15 = 60 Marks**

11. a) Use graphical method to solve the following LPP:

$$\text{Minimize } Z = -x_1 + 2x_2$$

subject to the constraints:

$$-x_1 + 3x_2 \leq 10,$$

$$x_1 + x_2 \leq 6,$$

$$x_1 - x_2 \leq 2, x_1, x_2 \geq 0. \quad (8)$$

- b) Solve the following LPP by using Simplex method:

$$\text{Maximize } Z = 10x_1 + 15x_2$$

subject to

$$2x_1 + x_2 \leq 26;$$

$$2x_1 + 4x_2 \leq 56;$$

$$-x_1 + x_2 \leq 5; \text{ and } x_1, x_2 \geq 0.$$

12. a) Write an algorithm for Big-M (Penalty) method. (8)

- b) Use the Big-M (Penalty) method to solve the following LPP:

$$\text{Minimize } Z = 5x_1 + 3x_2$$

subject to the constraints

$$\begin{aligned}
 2x_1 + 4x_2 &\leq 12; \\
 2x_1 + 2x_2 &\leq 10; \\
 5x_1 + 2x_2 &\geq 5; \text{ and } x_1, x_2 \geq 0.
 \end{aligned} \tag{7}$$

13. a) Write an algorithm for the NORTH-WEST Corner rule. (8)  
 b) Determine an initial basic feasible solution to the following transportation problem: (7)

	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	Supply
S <sub>1</sub>	1	5	3	3	34
S <sub>2</sub>	3	3	1	2	15
S <sub>3</sub>	0	2	2	4	12
S <sub>4</sub>	2	7	2	4	19
Demand	21	25	17	17	

(OR)

14. a) Write an algorithm for MODI method (8)  
 b) Four different jobs can be done on four different machines. The set up and take down time costs are assumed to be prohibitively high for changeovers. The matrix below give the cost in rupees of processing job  $i$  on machine  $j$ .

	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	M <sub>4</sub>
J <sub>1</sub>	5	7	11	6
J <sub>2</sub>	8	5	9	6
J <sub>3</sub>	4	7	10	7
J <sub>4</sub>	10	4	8	3

How should the jobs be assigned by Hungarian method to the various machines so that the total cost is minimized? (7)

15. A company operating 50 weeks in a year is concerned about its stocks of copper cable. This costs Rs. 240 a metre and there is a demand for 8,000 metres a week. Each replenishment costs Rs. 1250 for administration and Rs. 1,750 for delivery, while holding costs are estimated at 25 percent of value held a year. Assuming no shortages are allowed, what is the optimal inventory policy for the company?

How would this analysis differ if the company wanted to maximize profit rather than minimize cost? What is the gross profit if the company sell cable for Rs. 360 a metre.

16329473.67

(OR)

16. a) Explain types of Inventory cost. (8)  
b) A manufacturing company purchases 9000 parts of a machine for its annual requirements, ordering one-month usage at a time. Each part cost Rs. 20. The ordering cost per order is Rs. 15 and the carrying charges are 15% of the average inventory per year. You have been asked to suggest a more economical purchasing policy for the company. What advice would you offer, and how much would it save the company per year? (7)
17. In a railway marshalling yard, goods trains arrive at a rate of 30 trains per day. Assuming that the inter-arrival time follows an exponential distribution and the service time distribution is also exponential with an average 36 minutes. Calculate the following:  
a) the mean queue size (line length), and  
b) the probability that the queue size exceeds 10.  
If the input of trains increases to an average 33 per day, what will be the change in (a) and (b)?

(OR)

18. A supermarket has two girls serving at the counters. The customers arrive in a Poisson fashion at the rate of 12 per hour. The service time for each customer is exponential with mean 6 minutes. Find (i) the probability that an arriving customer has to wait for service, (ii) the average number of customers in the system, and (iii) the average time spent by a customer in the supermarket.

$$\begin{aligned} & l = 0.6 \\ & P_0 = 0.25 \\ & L_s = 0.15 \\ & L_q = 0.50 \\ & W_q = 0.50 \\ & W_s = 0.75 \end{aligned}$$

## PART - C

Answer the following

$1 \times 20 = 20$  Marks

19. a) Use two-phase simplex method to solve the following LPP:

$$\text{Maximize } Z = 5x_1 - 4x_2 + 3x_3$$

subject to the constraints:

$$2x_1 + x_2 - 6x_3 = 20,$$

$$6x_1 + 5x_2 + 10x_3 \leq 76,$$

$$8x_1 - 3x_2 + 6x_3 \leq 50, \text{ and}$$

$$x_1, x_2, x_3 \geq 0. \quad (10)$$

- b) Obtain an optimal solution to the transportation problem by MODI Method given in the following table: (10)

	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	Supply
S <sub>1</sub>	19	30	50	10	7
S <sub>2</sub>	70	30	40	60	9
S <sub>3</sub>	40	8	70	20	18
Demand	5	8	7	14	

\*\*\*

10/18  
20/37

**SASTRA DEEMED UNIVERSITY**  
(A University under section 3 of the UGC Act, 1956)

**End Semester Examinations**

**May 2024**

**Course Code: CSE318**

**Course: ALGORITHM DESIGN STRATEGIES & ANALYSIS**

**QP No. :U012-4**

**Duration: 3 hours**

**Max. Marks:100**

**PART - A**

**Answer all the questions**

**$10 \times 2 = 20$  Marks**

1. State Master theorem for solving recurrences.
2. Write the following rate of growth functions in increasing order.  
 $O(n^3), O(\log_2 n), O(\sqrt{n}), O(n^2), O(n \log_2 n),$   
 $O(n!), O(2^n), O(1), O(2^{2n}), O(\sqrt{n} \log_2 n), O(n)$
3. Compare the backtracking approach with the branch & bound approach.
4. What is Hamiltonian Cycle in a graph? Give an example.
5. Match the following.

a) Kruskal's Algorithm	i) Starting time & Finishing time
b) DFS Algorithm	ii) Min Priority Queue
c) BFS Algorithm	iii) SET concept
d) Dijkstra's Algorithm	iv) Shortest distance
6. Define residual capacity and residual graph in network flow problem.
7. Differentiate tractable and intractable problems.

8. Draw the diagram, which relates the different classes of problems such as P, NP, NP-Hard and NP-Complete.
9. Find the order of growth of the following sum.

$$\sum_{i=1}^n \sum_{j=1}^i (i + j + 1)$$

10. Suggest a best searching algorithm among linear and binary search for searching a key from a set of unordered elements. Justify the reason.

### PART - B

Answer any Four questions

4 x 15 = 60 Marks

11. Differentiate between 0/1 knapsack and fractional knapsack problems.

Consider the following fractional knapsack problem. Apply the greedy algorithm and solve the problem. What can be the best greedy choice to obtain the optimum result? Illustrate and compare the results of algorithms with three different greedy choice: (a) Item with Maximum Weight (b) Item with Maximum Profit (c) Item with Maximum Profit per Weight.

No. of Items: n = 8								
Item	1	2	3	4	5	6	7	8
Weight[1..8]	4	3	5	7	3	6	2	8
Profit[1..8]	12	5	14	9	8	26	7	32
Bag Capacity: W = 22								

12. The problem is to find the  $n^{\text{th}}$  number from the Fibonacci sequence. Design an algorithm by applying divide and conquer strategy to solve this problem. Verify the correctness of the algorithm by tracing the algorithm for the input  $n=7$ . Analyze the time complexity of the algorithm by obtaining the recurrence for the algorithm and solve it by using recursion tree method.

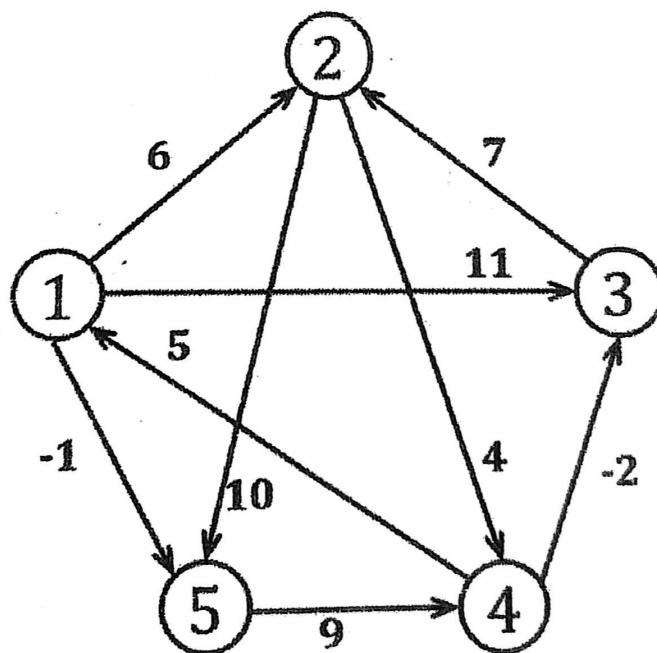
(The Fibonacci sequence is a type series where each number is the sum of the two that precede it. It starts from 0 and 1 usually. The Fibonacci sequence is: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, and so on)

13. Brief on approximation algorithms. State the bin-packing problem. Explain the various approximation algorithms for solving the bin-packing problem with proper examples.

14. Illustrate the steps in solving the following sum of subset problem by using backtracking approach through state space tree. Write the algorithm and mention all the bounding conditions for backtracking in solving problem.

$$n = 5, \text{Sum} = 10, W[1..5] = \{1, 6, 5, 3, 4\}$$

15. Predict the design strategy used in Floyd-Wharshall's all-pairs shortest path algorithm. Apply the algorithm and show the step-by-step results of algorithm for the following graph. From the result, find the shortest path from the vertex '3' to vertex '5'.



16. Describe Travelling Salesperson Problem (TSP). Apply the branch and bound strategy for solving TSP for the graph with the following cost matrix. Assume the starting city is 'A'.

	A	B	C	D
A	$\infty$	5	13	8
B	6	$\infty$	$\infty$	19
C	12	$\infty$	$\infty$	7
D	11	3	4	$\infty$

### PART - C

**Answer the following**

**1 x 20 = 20 Marks**

17. a) Compare the following:
- i) Divide-and-Conquer vs Dynamic Programming.
  - ii) Dynamic Programming vs Greedy Approach. (6)
- b) Describe Clique Decision Problem. Prove that the Clique Decision Problem is NP-Hard with an example. (6)
- c) Apply dynamic programming approach for solving the following string-editing problem. Find the minimum number of editing operations required for transforming the string X to Y. Transform the string X to Y using the operations. (8)

$$X[1..9] = \{ 'I', 'N', 'T', 'E', 'N', 'T', 'I', 'O', 'N' \}$$

$$Y[1..9] = \{ 'E', 'X', 'E', 'C', 'U', 'T', 'I', 'O', 'N' \}.$$

\*\*\*\*\*

**SASTRA DEEMED UNIVERSITY**  
(A University under section 3 of the UGC Act, 1956)

**End Semester Examinations**

**May 2024**

**Course Code: CSE308**

**Course: OPERATING SYSTEMS**

**QP No. :U364-4**

**Duration: 3 hours**

**Max. Marks:100**

**PART- A**

**Answer all the questions**

**$10 \times 2 = 20$  Marks**

1. State the meaning and purpose of dual mode of operation of operating systems.
2. Mention the two approaches for implementing shells. Choose an approach that is as the best with justification.
3. What is the role of system call interface in executing system calls?
4. Differentiate job queue and ready queue with the schedulers associated with each queue.
5. If an application consist of 80 % of parallel code and the system has 5 cores CPU, then compute the performance gain.
6. If the producer and consumer processes are executed concurrently without synchronization, then trace the sequence of execution that could result in the counter being 6 at the end.
7. Construct a resource allocation graph based on the following table and find whether it has the possibility of a deadlock.

	Allocation		Request	
	R1	R2	R1	R2

P1	1	0	0	1
P2	0	1	1	0
P3	0	1	0	0

8. Demonstrate the prevention of circular wait with an example.
9. Given that the size of memory address is 32 bits and the size of a frame is 8 KB, then what is the maximum number of frames that can be addressed and what will be the size of physical memory that can be addressed with 32 bits?
10. Distinguish between tracks, sectors and cylinders.

### PART - B

**Answer any FOUR questions**

**4 x 15 = 60 Marks**

11. a) Summarize the services offered by operating systems. (7)  
 b) Describe the different structures of operating systems with their merits and demerits. (8)
12. a) Schedule the following processes as per multi-level feedback scheduling with three queues having the time quantum of 2,3 and 4 respectively. Compute average turnaround time of the processes. Draw a gantt chart. (9)

Process	Arrival time	Burst time
P0	0	7
P1	3	4
P2	4	2
P3	6	6
P4	10	3

- b) Discuss the types of threads, thread models and scheduling of threads. (6)
13. Discuss the critical section problem along with the various techniques for dealing with it and analyze whether they fulfill all the three requirements.

14. Write the banker's algorithm. Using the algorithm, find whether the system is in a safe state or not. Then decide whether the requests of processes for additional resources can be accepted or not.

Max					Allocation				
	R1	R2	R3	R4		R1	R2	R3	R4
P1	4	6	4	6	P1	2	3	1	1
P2	2	4	1	5	P2	0	2	0	2
P3	3	2	2	0	P3	2	1	2	0
P4	4	3	3	4	P4	1	2	1	2

Available			
R1	R2	R3	R4
1	1	0	2

Requests:

- a) P1 makes request for (0,1,1,0).
- b) P3 makes request for (1,0,1,0).
- c) P2 makes request for (1,0,0,0).
- d) P2 makes request for (0,0,0,1).

15. a) Compare paging and segmentation. (9)
- b) Calculate the number of page faults under Optimal and LRU for the following page requests when there are 3 frames in memory: 1,2,3, 4, 5, 2, 6, 7, 4, 8,9, 2, 5, 1, 6, 2, 7. (6)
16. a) Assume that a disk has 200 tracks and the head is currently at 54. Calculate the seek time for completing the following requests under SSTF, SCAN, and Look algorithms: 165, 78, 23, 96, 44, 7, 20, 24, 58. (9)
- b) Discuss the different ways of structuring the page table. (6)

## **PART - C**

**Answer the following**

**1 x 20 = 20 Marks**

17. a) Represent the different states and state transitions of a process in a process state transition diagram. Include a state called "swapped" at an appropriate place on the diagram. In a swapped state a process gets swapped. Describe the various possible transitions between the different states with their causes. (7)
- b) Develop a solution for the reader-writer problem using semaphore. (7)
- c) Illustrate the file allocation methods with example. (6)

\*\*\*

**SASTRA DEEMED UNIVERSITY**  
(A University under section 3 of the UGC Act, 1956)

**End Semester Examinations**

**May 2024**

**Course Code: MGT207**

**Course: INTRODUCTION TO INNOVATION, IP  
MANAGEMENT & ENTREPRENEURSHIP**

**QP No. :U288-4**

**Duration: 3 hours**

**Max. Marks:100**

**PART - A**

**Answer all the questions**

**$10 \times 2 = 20$  Marks**

1. Differentiate invention and innovation with examples.
2. Discuss all the characteristics of innovation.
3. Describe the concept of thinking hats to create creativity.
4. State the reasons for entering into strategic alliance.
5. Mention the concept of turnkey project with an example.
6. Explain the different types of waste in Lean management.
7. Compare and contrast radical and incremental innovation.
8. List down the various market strategies for going abroad.
9. Explain the need for intellectual property rights.
10. Discuss the benefits of GI with suitable example.

## PART - B

**Answer any FOUR questions**

**4 x 15 = 60 Marks**

11. "Knowledge is considered as a transferable and inevitable resource that is essential for creating innovations". Explain the process of knowledge management in detail.
12. Explain the process of idea creation using the different techniques of idea creation.
13. Dr. Saraswathy argues that the causal logic is not suited for entrepreneurship processes that is characterized by uncertainties and risks. Explain the process recommended for entrepreneurs for better decision making.
14. Compare and contrast trademark and copyright indicating its legal implications.
15. "Understanding the different types of innovation helps companies align their innovation efforts with their overall strategic goals". Illustrate with various types of innovation.
16. Describe the process of design thinking with clear mention of all the steps.

## PART - C

**1 x 20 = 20 Marks**

**Answer the following**

17. Naveen has a bright idea to start a new venture with his new app for blind persons. He has to pitch his idea with a proper business plan. Sketch out a business plan, with details of all the elements, namely the Market plan, production plan, organizational plan, financial plan with feasibility aspects and technical plan. Ensure the business plan attracts investors to fund for his venture.

\*\*\*

# **SASTRA DEEMED UNIVERSITY**

(A University under section 3 of the UGC Act, 1956)

## **End Semester Examinations**

**May 2024**

**Course Code: MCT309M**

**Course: INDUSTRIAL MANIPULATORS**

**QP No. :U257-M**

**Duration: 3 hours**

**Max. Marks:100**

### **PART – A**

**Answer all the questions**

**$10 \times 2 = 20$  Marks**

1. What are the different components of a homogenous transformation matrix? Answer with an example.
2. If a frame first rotates about Z-axis and then translates along Z axis, whatever transformation matrix you would get, would it be same if you translate first and then rotate about Z-axis? Justify your answer.
3. What is the inference can you draw from question no 2?
4. What is the role of D-H parameters in defining a link with respect to previous link?
5. A Cartesian manipulator has its end-effector at (10,15,20). What would be its inverse kinematic solution?
6. What is the difference between a planar robot and spatial robot? Give example.
7. What kind of trajectory planning will you adopt for the following operations: welding, assembly of body parts of a car, stacking of boxes from a belt conveyor, painting.

8. Out of joint space and cartesian space trajectory plannings, which one would be more computationally tasking and why?
9. How a Cobot is different from industrial robot?
10. What is a digital twin? Give an example.

### **PART - B**

**Answer all the questions**

**4 x 15 = 60 Marks**

11. There are two cameras to track the convoy carrying an eminent personality. One is at the gate and the second one is at the roof top. The transformation matrix of the gate camera with respect to the roof top camera is given by

$$\begin{bmatrix} 0 & -1 & 0 & 20 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & -30 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

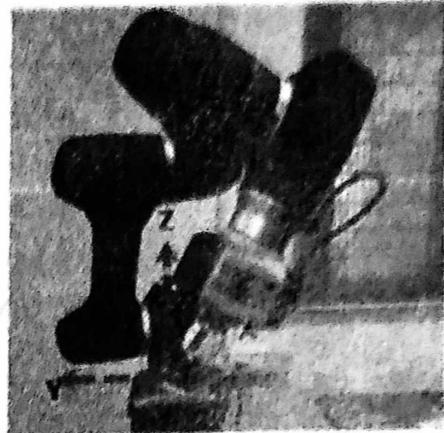
The convoy is located at  $[-200 \ -300 \ -25]^T$  with respect to roof top camera. What would be the coordinates of the convoy with respect to Gate camera?

**(OR)**

12. In a task space operation with the Cobot, Shyam tried to rotate the end-effecter about X axis of the base. As you know, for this operation, you have to change the Rx value on the teach pendant.



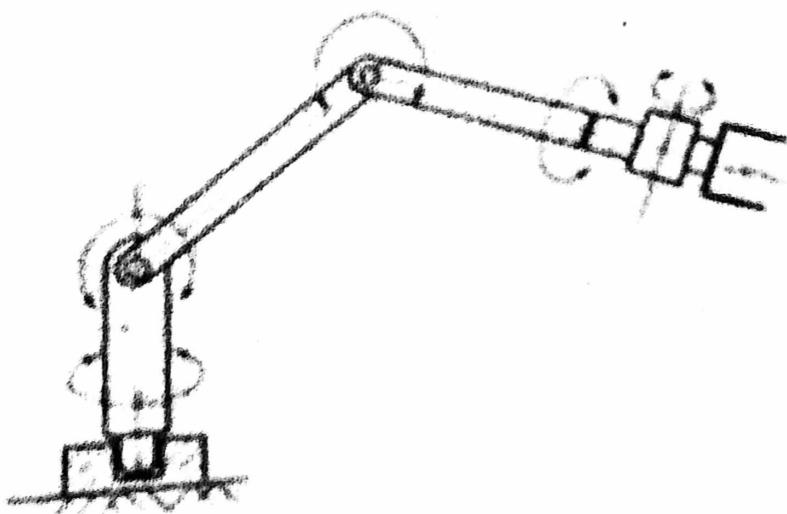
(configuration of the Cobot)



(Configuration of Cobot with base frame)

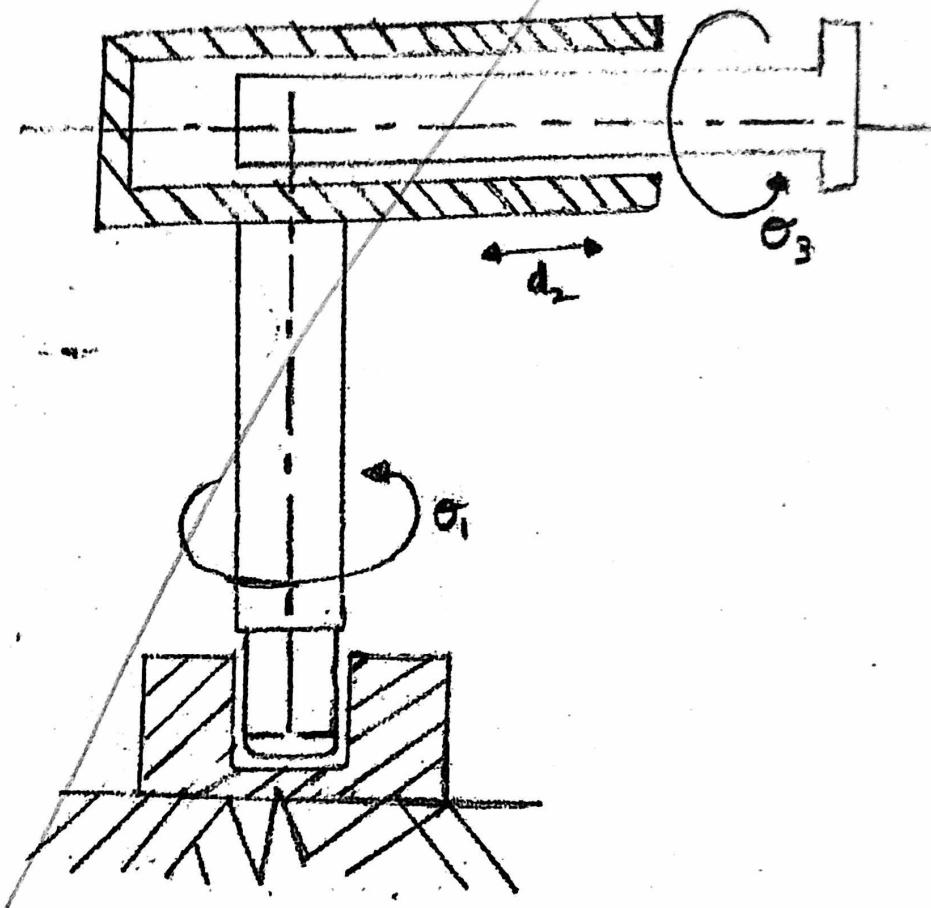
In the instance shown in the above diagram,  $R_x=91.17^\circ$ ,  $R_y=153.15^\circ$  and  $R_z=91.04^\circ$ . Determine the orientation of end-effector frame in the form of a rotation matrix. Remember that Doosan Cobot follows ZYZ Euler angle notation to represent the end-effector frame. Rewrite the matrix by neglecting the smaller terms and verify that the matrix represents a rotation matrix about X-axis and determine the angle of rotation.

13. Fix the frames and determine the DH parameters of the following 5-DOF manipulator after bringing it to home configuration.



(OR)

14. Fix the frames, determine DH parameters and determine the forward kinematics modes of the following manipulator (assume suitably, if required).



15. Base joint of the manipulator in Question No.13 has to rotate from  $30^\circ$  to  $150^\circ$  in 5 seconds. Fit a cubic polynomial for smooth trajectory of the joint. Plot the displacement, velocity and acceleration of the joint.

**(OR)**

16. What will you do to do the followings in SIMSCAPE.

- To have a base frame.
- To have the second joint axis perpendicular to the first joint axis. (give an example)
- To give sinusoidal input to a joint in terms of radians.

17. a. Write briefly about different kinds of robot programming.  
b. Describe the safety features in a Cobot.

**(OR)**

18. a. Write briefly about different kinds of robot cell designs.  
b. Write about the last 2 levels of digital twins.

**PART - C**

**Answer the following**

**1 x 20 = 20 Marks**

19. Answer the following questions about your hands-on project on making a 3-DOF robot.
- Draw the line diagram of the robot that you made. (3)
  - Write a few lines about the motors that you used. (3)
  - Draw the circuit connections between Arduino with the motors and any other device. (8)
  - What code did you write to rotate the servo motors? (4)
  - What are the lessons that you learn from this hands-on? (2)

\*\*