



MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

FOURTH YEAR SECOND SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (MATHEMATICS AND COMPUTER SCIENCE)

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

SCO 413 ROBOTICS

DATE: 7/12/2021

TIME: 2.00-4.00 PM

INSTRUCTIONS:

1. Answer **Question 1** and **Any Other Two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

QUESTION ONE (COMPULSORY) (30 MARKS)

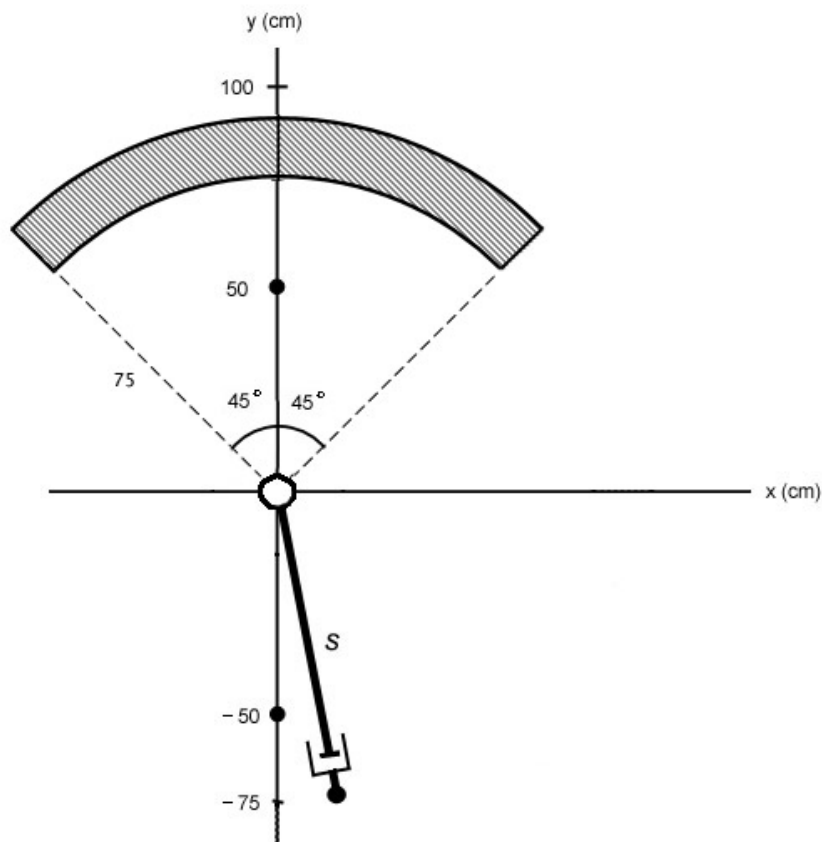
- a) Explain the following motion for robotic arm (6 marks)
 - i. forward kinematics
 - ii. inverse kinematics
- b) A student is tasked to design a robot that explores an environment (can be thought of as 2D) of which only the dimensions are known and assuming that you are using an occupancy grid to represent the world. Explain the following
 - i. How to initialize the grid? (4 marks)
 - ii. How to define unexplored space and good target locations to move to to explore space (4 marks)
- c) State three Laws of robotics (3 marks)
- e) Briefly explain three areas where the robotics can be applied (6 marks)
- e) Explain the basic aspects of the robotics? (3 marks)
- g) Give the number of degrees of freedom that a wrist have (4 marks)

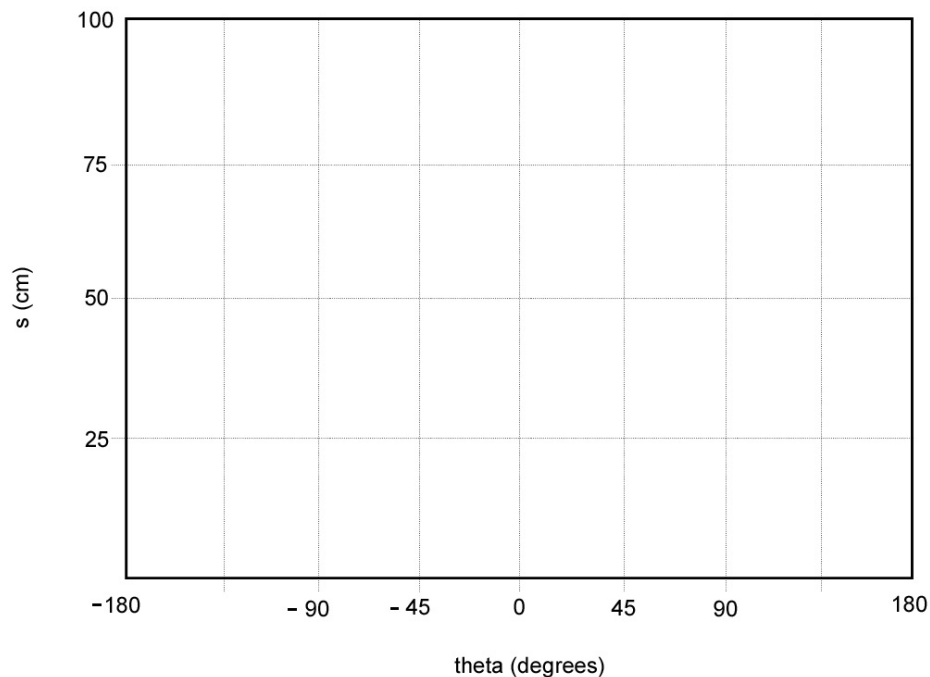
QUESTION TWO (20 MARKS)

- a) State Five basic components of a robot (5 marks)
- b) Discuss different features of Trajectory planning in Robots (6 marks)
- c) Explain the implementation of AI in the robots (3 marks)
- d) Explain the working of the following sensors; (6 marks)
 - i. Light sensor
 - ii. Touch sensor

QUESTION THREE (20 MARKS)

- a) Describe the method commonly used in industrial manipulators. (5 marks)
- b) The robot below has a revolute joint with angle θ at the base which rotates a prismatic joint with length s whose range of motion is 0 to 100 cm. The base joint has no limits. The robot is shown in its initial position. There are 3 obstacles: two point obstacles at (0,50) and (0,-50), and a curved quarter circular wall with radius 75 cm. Given the workspace below, draw the configuration space (7 marks)





- c) For R-P-R arm manipulator, obtain Jacobian to express the Cartesian velocities in terms of Joint velocities. (4 marks)
- d) Explain in detail about the Trajectory for cubic polynomials. (4 marks)

QUESTION FOUR (20 MARKS)

- a) Consider the robot model given by $x_{k+1} = A_k x_k + B_k(u_k + t_k) + v_k$, where t_k is noise in the control input signal with $E(t_k) = 0$ and $E(t_k t_k^T) = \Sigma_k$. (The other terms are as usual.) Explain the state covariance prediction (6 marks)
- b) Describe two general characteristics of control methods used in walking robots (6 marks)
- c) State four types of motors used in industrial robots (4 marks)
- d) Describe how to determine the degree of freedom in robotics (4 marks)

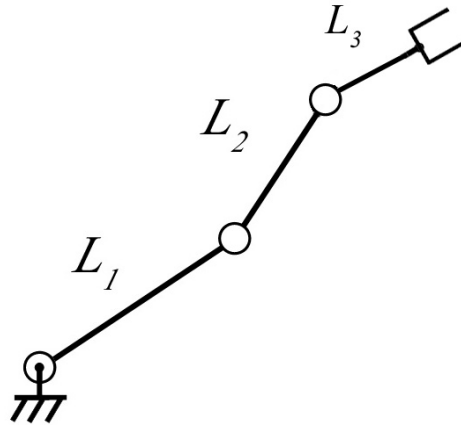
QUESTION FIVE (20 MARKS)

- a) Explain the steps to implement RPA in an enterprise (6 marks)
- b) Describe how topological mapping is done conceptually and how the robot would use the topological map for localization. (8 marks)

c) Concisely describe the following:

(6 marks)

- i) the set of points that the end effector can position and orient the last link for a three link manipulator where $L_1 > L_2 > L_3$ and $L_2 + L_3 > L_1$.



- ii) the set of points that the end effector can position and orient the last link for a two-link manipulator where $L_1 < L_2$

