72314

ROBOTICS PAPER SOLUTION

Q1	Attempt any **FOUR** of the followings	
a)	**Degrees Of Freedom or mobility for robots:** **Let us consider a manipulator with n rigid moving links and m joints** C_i: **Connectivity of i-th joint; i = 1, 2, 3,........., m** **No. of constraints put by i-th joint** $= (3 - C_i)$ **Total no. of constraints** $= \sum_{i=1}^{m}(3 - C_i)$ **Mobility of the manipulator** $M = 3n - \sum_{i=1}^{m}(3 - C_i)$ **It is known as** Grubler's criterion.	
b)	The **DH parameters** were first appeared in 1955 (Denavit and Hartenberg, 1955) to represent a directed line which is nothing but the axis of a lower pair joint. A robot manipulator consists of several links connected by, usually, single degree of freedom joints, say, a revolute or a prismatic joint. In order to control the end-effector with respect to the base, it is necessary to find the relation between the coordinate frames attached to the end-effector and the base. This can be obtained from the description of the coordinate transformations between the coordinate frames attached to all the links and forming the overall description in a recursive manner. The four DH parameters are defined as follows: (a) di (Joint offset) (b) θi (Joint angle) (c) ai (Link length) αi (Twist angle	
c)	**Robotic vision systems** consist of one or more cameras, special-purpose lighting, software, and a robot or robots. The camera takes a picture of the working area or object the robot will grip and software searches the image for features that let it determine position and orientation. This information is sent to the robot controller and the programmed positions are updated. Depending on the application, the camera might be mounted on the robot or could be in a fixed position within the cell. Calibration is usually needed to relate the vision system coordinate space to the robot.	
d)	**Legged locomotion and balancing in humanoids** For planar dynamic systems with equations of motion of the form, $M(\theta)$ $\ddot{\theta} = \tau - N(\theta, \dot{\theta})$ where θ is a vector of joint angles, M is the inertia matrix, τ are the joint torques, and N is a vector containing the gravitational, centripetal and coriolis forces.	
e)	Robots are in use for many of the industrial and service operations from last two decades because of the availability of electro- mechanical devices. The application areas of the robot are shown by the figure given below.	

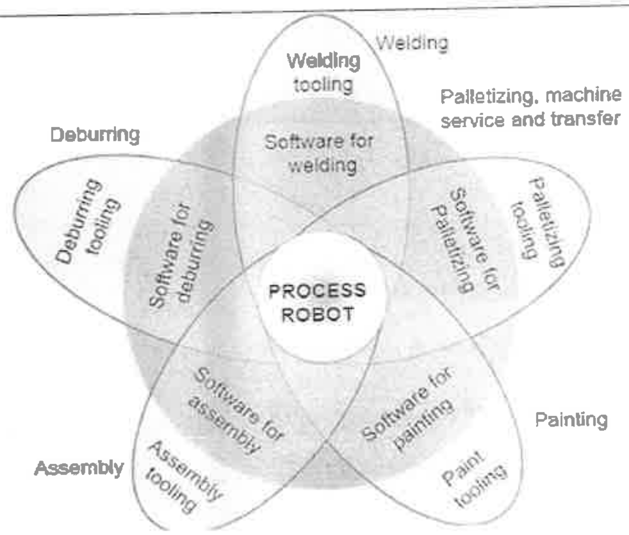
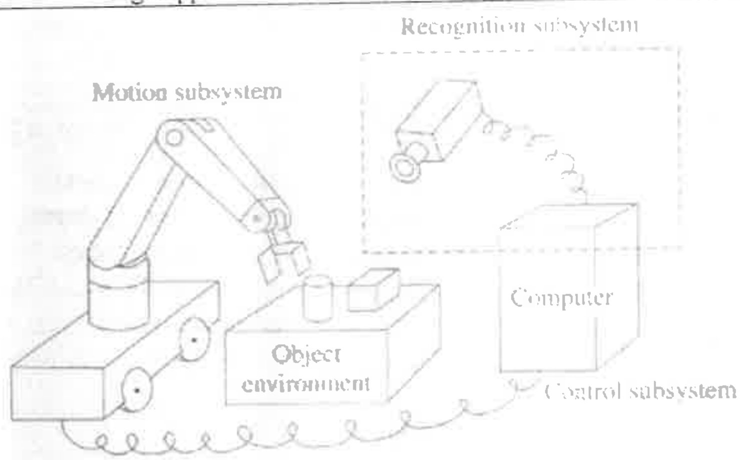


Fig: Applications of robots in industry and manufacturing

Q2 a)



Q2 b)

Direct kinematics: Here link parameters (link lengths) and joint variables (typically angles) are given and one has to find out the position and orientation of the end-effector (EE).

Inverse kinematics: Given link parameters and position and orientation of the end effector, one has to find joint variables.

Q3 a)

$$\mathbf{T}_1 = \begin{bmatrix} c_1 & -s_1 & 0 & a_1c_1 \\ s_1 & c_1 & 0 & a_1s_1 \\ 0 & 0 & 1 & b_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad \mathbf{T}_2 = \begin{bmatrix} c_2 & -s_2 & 0 & a_2c_2 \\ s_2 & c_2 & 0 & a_2s_2 \\ 0 & 0 & 1 & b_2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{T}_3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & b_3 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad \mathbf{T}_4 = \begin{bmatrix} c_4 & -s_4 & 0 & 0 \\ s_4 & c_4 & 0 & 0 \\ 0 & 0 & 1 & -b_4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The resultant forward kinematics for position then can be obtained as, $\mathbf{T} = \mathbf{T}_1\mathbf{T}_2\mathbf{T}_3\mathbf{T}_4$, which yields

$$\mathbf{T} = \begin{bmatrix} c_{124} & -s_{124} & 0 & a_1c_1 + a_2c_{12} \\ s_{124} & c_{124} & 0 & a_1s_1 + a_2s_{12} \\ 0 & 0 & 1 & b_1 + b_2 + b_3 - b_4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

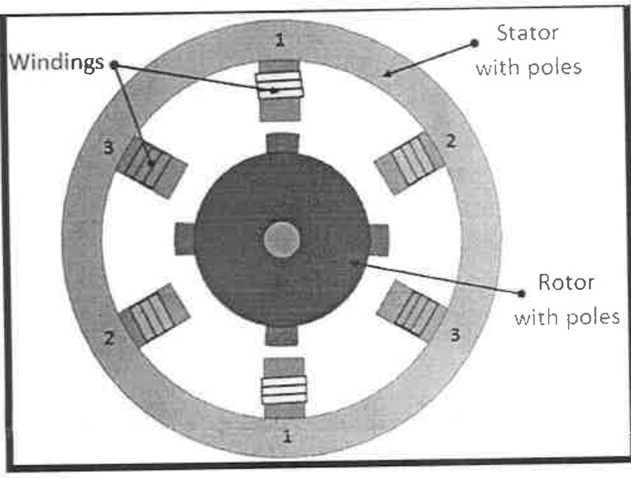
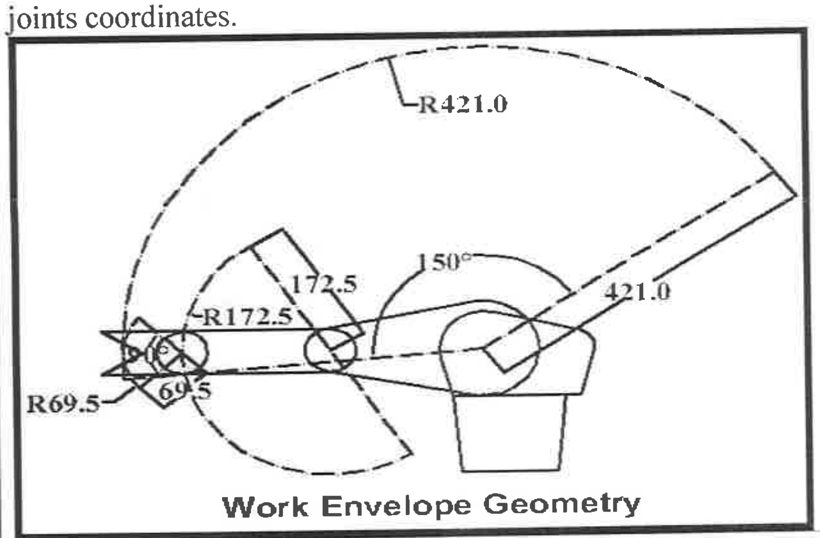
where $s_{124} \equiv \sin\theta_{124}$, $c_{124} \equiv \cos\theta_{124}$, and $\theta_{124} \equiv \theta_{12} + \theta_4$.

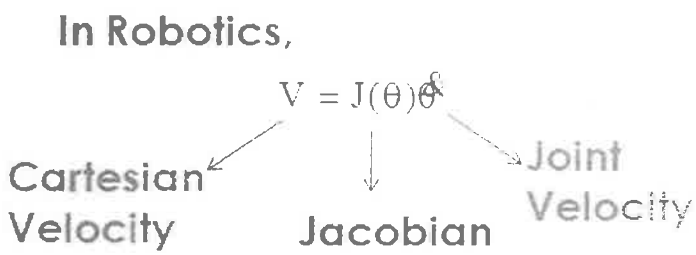
Q3 b)

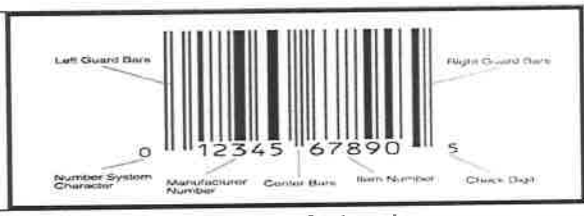
Following are the principles of material handling:

1. Planning principle: All handling activities should be planned.

	2. Systems principle: Plan a system integrating as many handling activities as possible and co-coordinating the full scope of operations (receiving, storage, production, inspection, packing, warehousing, supply and transportation). 3. Space utilization principle: Make optimum use of cubic space. 4. Unit load principle: Increase quantity, size, weight of load handled. 5. Gravity principle: Utilize gravity to move a material wherever practicable. 6. Material flow principle: Plan an operation sequence and equipment arrangement to optimize material flow. 7. Simplification principle: Reduce combine or eliminate unnecessary movement and/or equipment. 8. Safety principle: Provide for safe handling methods and equipment. 9. Mechanization principle: Use mechanical or automated material handling equipment. 10. Standardization principle: Standardize method, types, size of material handling equipment. 11. Flexibility principle: Use methods and equipment that can perform a variety of task and applications. 12. Equipment selection principle: Consider all aspect of material, move and method to be utilized. 13. Dead weight principle: Reduce the ratio of dead weight to pay load in mobile equipment. 14. Motion principle: Equipment designed to transport material should be kept in motion. 15. Maintenance principle: Plan for preventive maintenance or scheduled repair of all handling equipment. 16. Idle time principle: Reduce idle time/unproductive time of both MH equipment and man power. 16. Maintenance principle: Plan for preventive maintenance or scheduled repair of all handling equipment. 17. Obsolescence principle: Replace obsolete handling methods/equipment when more efficient method/equipment will improve operation. 18. Capacity principle: Use handling equipment to help achieve its full capacity. 19. Control principle: Use material handling equipment to improve production control, inventory control and other handling. 20. Performance principle: Determine efficiency of handling performance in terms of cost per unit handled which is the primary criterion.	
Q4 a)	An autonomous mobile robot is a machine that operates in an unknown and unpredictable environment. The fuzzy navigation technique, which is accomplished to generate satisfactory direction and velocity manoeuvers of the autonomous robot, is used for the robot navigation to reach its goal safely moving on unknown static terrains.	

Q4 b)	 **Variable Reluctance Motor** Figure 4b1 shows the construction of Variable Reluctance motor. The cylindrical rotor is made of soft steel and has four poles as shown in Fig.4b1. It has four rotor teeth, 90° apart and six stator poles, 60° apart. Electromagnetic field is produced by activating the stator coils in sequence. It attracts the metal rotor. When the windings are energized in a reoccurring sequence of 2, 3, 1, and so on, the motor will rotate in a 30° step angle. In the non-energized condition, there is no magnetic flux in the air gap, as the stator is an electromagnet and the rotor is a piece of soft iron; hence, there is no detent torque. This type of stepper motor is called a variable reluctance stepper.	
Q4 c)	Workspace Analysis: The workspace analysis of a robot is defined as analysis of a set of all end effector configurations of robot which can be reached by some choice of joints coordinates. 	
Q5 a)	Participating in vocal exchange is an important part of many social interactions. Robotic auditory systems have focused on recognition of a small vocabulary of hard-wired commands. Research on understanding speech patterns in a more fundamental way. Currently implementing an auditory system to enable our robots to recognize vocal affirmation, prohibition, and attentional bids while interacting with a human. By doing so, the robot will obtain natural social feedback on which of its actions have been successfully executed and which have not. Prosodic patterns of speech (including pitch, tempo, and tone of voice) may be universal, as infants	

	have demonstrated the ability to recognize praise, prohibition and attentional bids even in unfamiliar languages.	
Q5 b)	***Linear variable differential transformer (LVDT)*** Linear variable differential transformer (LVDT) is a primary transducer used for measurement of linear displacement with an input range of about ± 2 to ± 400 mm in general. It has non-linearity error ± 0.25% of full range. Figure 3 shows the construction of a LVDT sensor. It has three coils symmetrically spaced along an insulated tube. The central coil is primary coil and the other two are secondary coils. Secondary coils are connected in series in such a way that their outputs oppose each other.	
Q5 c)	In joint space trajectory planning each path point is specified in terms of a desired position and orientation of the end effector frame relative to the base frame. This technique is very useful if the single joint or group of joints has to be moved between two positions. It becomes very difficult to visualize the required motion at all the joints to ensure a particular motion of the end effector or the tool. The motion between the two points is unpredictable. In Cartesian space technique each path point is explicitly specified in a Cartesian space. It is much easier and natural for the robot operator to specify a trajectory in a Cartesian space. For Example to plan a welding task, peg in hole, tracking a conveyor etc. 	
Q6 a)	Automated guided vehicle systems (AGVs), commonly known as driverless vehicles, are turning out to be an important part of the automated manufacturing system. With the shift from mass production to mid-volume and mid-variety, flexible manufacturing systems, are increasingly in use. They require not only machine flexibility but also materialhandling, storage, and retrieval flexibility. Hence, the importance of AGVs has grown in manifold. It is a battery-powered driverless vehicle with programming capabilities for destination, path selection, and positioning.	
Q6 b)	OBJECTIVES OF BARCODING The main objectives of barcoding documents in a library are: - To achieve accuracy - Time saving of users - To reduce overall cost - To make stock verification an easy process - To Improve operational efficiency	

		
Q6 c)	Interfacing is one of the important concepts in microcontroller because the microcontroller is a CPU that can perform some operation on a data and gives the output. However to perform the operation we need an input device to enter the data and in turn output device displays the results of the operation. Interfacing is the process of connecting devices together so that they can exchange the information and that proves to be easier to write the programs. There are different type of input and output devices as for our requirement such as LEDs, LCDs, 7segment, keypad, motors and other devices.	
Q6 d)	Humanoid Motion Capture technologies: Acquiring the data invariably requires a motion capture system. There are number of commercially available systems employed in the animation industry. The most common technology is a suit, outfitted with optical or hall-effect position feedback sensors, which is worn by a human performer (Bodenheimer & Rose 1997). Another technique involves mounting an array of cameras around a staged area. Markers placed on a performer allow tracking of limb position. A time series of joint positions can then be calculated off-line. Using minimal body markers, can automatically generate a kinematic model of the performer which is mapped to the body of an avatar or humanoid robot. This type of system is ideal from the imitation perspective. Unfortunately, the technology is not yet mature enough to be used without a large research investment.	
Q6 e)	Based on typical applications, humanoid robots can be categorized into Healthcare, Educational and Social humanoid robot. Healthcare humanoid robots are used by patients at home or healthcare centers to treat and improve their medical conditions. These robots either require a human controller or are fully preprogrammed to assist patients. Educational humanoid robots are for students and are used in education centers or home to improve education quality and increase involvement in studies.These robots are typically manually controlled robots. Social humanoid robots are used by individuals or organizations to help and assist people in their daily life activities.	