هندسة روبوت

Ministry of Higher Education

High Institute of Engineering & Technology in new Damietta

Subject	Robotic engineering	Subject code	CEE511
Electronics and Communication Engineering Department		Level	5
Time	1.5 hours	Date	29-7-2018

Mid Term Examination Summer Semester 2017-2018 by Dr. Amira. Elsonbaty

-Answer all the following questions
-Illustrate your answers with sketches when necessary

-No. For questions: 2
-Total marks: 20 marks

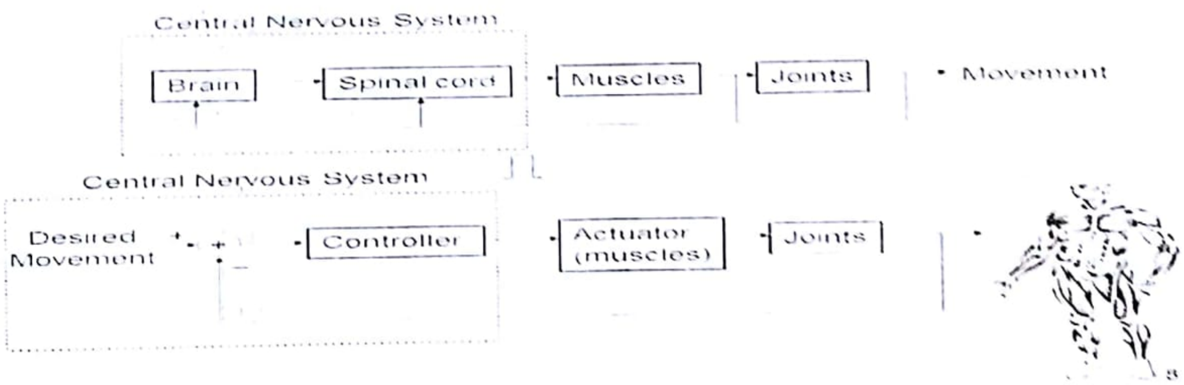
Question (1) (10 MARKS)

1. [4marks] Write down the definition of a robot? & What are the basic elements of robots?

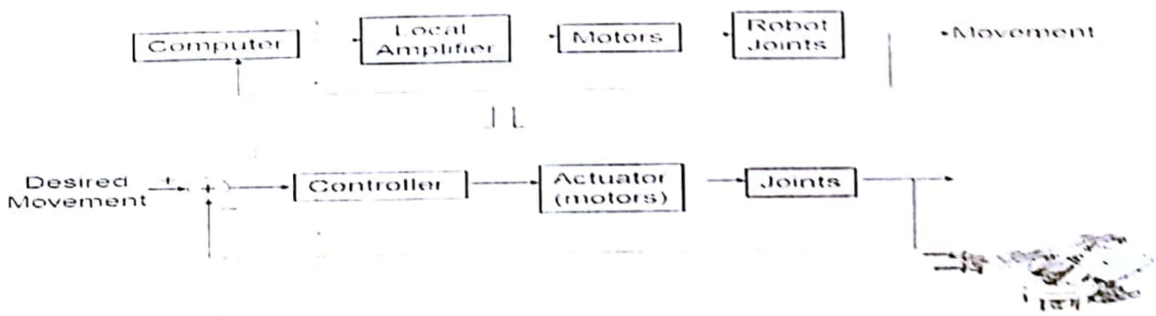
Answer: A **robot** is a machine—especially one programmable by a computer— capable of carrying out a complex series of actions automatically. Robots can be guided by an external control device or the control may be embedded within. Robots may be constructed to take on human form but most robots are machines designed to perform a task with no regard to how they look.

2. [4marks] Sketch robot closed loop system & human closed loop?

Human Closed Loop System Box Diagram



Robot Closed Loop System Box Diagram



3. [2marks] Talk about the degree of freedom of a robotic arm?

Answer:

- Degree of freedom DOF - number of parameters describing the pose/configuration of the robot
- For manipulator robots, there are a few common terms – simple terms – that you should know.
- A **link** makes up the 'skeleton' of the robot, and these are connected by **joints**.
- This is exactly like how your arm is made up of the base joint (shoulder) and is connected by a link to another joint (elbow), yet again connected to the final joint (wrist) via another link.

Degrees of Freedom

Each plane in which a robot can maneuver.

ROTATE BASE OF ARM

PIVOT BASE OF ARM

BEND ELBOW

WRIST UP AND DOWN

WRIST LEFT AND RIGHT

ROTATE WRIST

Question (2) (10 MARKS)

A: [5marks]. **Discusses** the differential drive kinematic & differential motion cases of wheeled robot?

Answer

-Kinematics of Differential drive is the most common kinematic choice. Difference in wheels' speeds determines its turning angle

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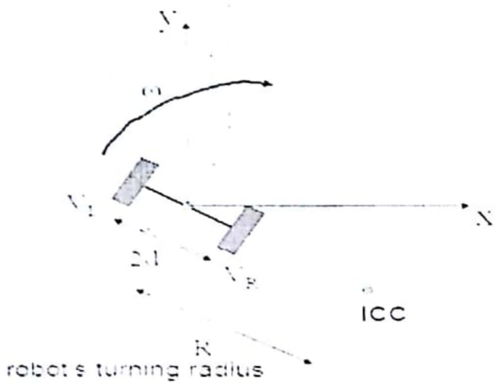
-Differential drive mobile robot
• Two wheels, with diameter , point P centered
• Between two wheels is the origin of the robot frame
• Each wheel is a distaCne e from the center

Kinematics of Differential drive – robot's velocity



1) Specify system measurements
   - consider possible coordinate systems

2) Determine the point (the radius) around which the robot is turning
   - each wheel must be traveling at the same angular velocity

3) Determine the robot's speed around the ICC and then linear velocity

$$\omega(R+d) = V_L$$
$$\omega(R-d) = V_R$$

Thus,

$$\omega = (V_R - V_L) / 2d$$
$$R = 2d(V_R + V_L) / (V_R - V_L)$$

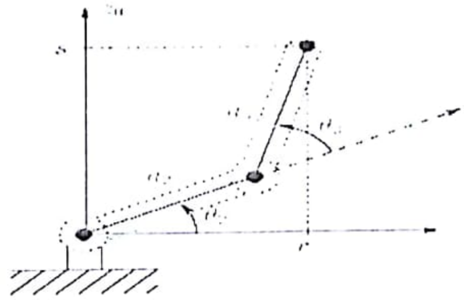
So, the robot's velocity is $V = \omega R = (V_R + V_L) / 2$

A *differential drive* is made of two parallel drive wheels on either side of the robot, powered separately, and one or more casters (pivoting wheels) which help support the weight but that have no active role. It is called a differential drive because the robot motion vector results from two independent components: it's of no relation to the differential gear, which isn't necessarily used in the configuration.

When both the drive wheels turn in the same direction at the same speed, the robot goes straight. If the wheels rotate at the same speed but in opposite directions, the robot turns in place, pivoting around the midpoint of the line that connects the drive wheels. The table below shows the behavior of a differential drive robot according to the direction of its wheels (assuming that when it's in motion they run at the same speed).

Left Wheel	Right Wheel	Robot
Stationary	Stationary	Rests stationary
Stationary	Forward	Turns counterclockwise pivoting around the left wheel
Stationary	Backward	Turns clockwise pivoting around the left wheel
Forward	Stationary	Turns clockwise pivoting around the right wheel
Forward	Forward	Goes forward
Forward	Backward	Spins clockwise in place
Backward	Stationary	Turns counterclockwise pivoting around the right wheel
Backward	Forward	Spins counterclockwise in place
Backward	Backward	Goes backward

B: [5marks]. Consider the three degree-of-freedom planar robot arm shown in Figure. The arm consists of one fixed link; all the links are connected by revolute joints whose joint axes are all perpendicular to the plane of the links. **Describe Forward Kinematic Equations.**



Given $\ell_1, \ell_2, \theta_1, \theta_2$ as fixed parameters of links and joint variable angles, find position X_B, Y_B, X_P, Y_P and orientation angles α_1, α_2 of the end effectors.

Solution :

From geometry of mechanism(Figure 15.2), we have

$$X_B = \ell_1 \cos\theta_1,\ Y_B = \ell_1 \sin\theta_1$$
$$X_P = \ell_1 \cos\theta_1 + \ell_2 \cos(\theta_1 + \theta_2)$$
$$Y_P = \ell_1 \sin\theta_1 + \ell_2 \sin(\theta_1 + \theta_2)$$

And the orientation is $\alpha_1 = \theta_1,\ \alpha_2 = \theta_1 + \theta_2$