INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	ROBOTICS
Course Code	:	AME533
Program	:	B.Tech
Semester	:	VI
Branch	:	Mechanical Engineering
Section	:	A & B
Academic Year	:	2019 – 2020
Course Faculty	:	Mr. A Anudeep Kumar, Assistant Professor

COURSE OBJECTIVES:

	The course should enable the students to:
I	Develop the knowledge in various robot structures and their workspace.
II	Develop the skills in performing kinematics analysis of robot systems.
III	Provide the knowledge of the dynamics associated with the operation of robotic systems.
IV	Provide the knowledge and analysis skills associated with trajectory planning.
V	Understand material handling and robot applications in industries.

COURSE OUTCOMES:

CO 1	Understand characteristic features of robots and usage of different grippers for industrial applications.
CO 2	Understand direct and inverse kinematics of robot structure.
CO 3	Illustrate Differential Kinematics of planar and spherical manipulators.
CO 4	Understand classification of robot actuators and trajectory planning.
CO 5	Remember material handling and applications in manufacturing.

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		UNIT-I				
1	Define Automation.	Automation is the technology by which a process or procedure is accomplished without human assistance.	Understand	CO 1	CLO 1	AME533.01
2	Define Fixed Automation.	Fixed automation is a system in which the sequence of processing (or assembly)	Remember	CO 1	CLO 2	AME533.02

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		operations is fixed by the equipment configuration. Each of the operations in the sequence is usually simple, involving perhaps a plain linear or rotational motion or an uncomplicated combination of the two.				
3	Explain Programmable Automation.	In programmable automation the production equipment is designed with the capability to change the sequence of operations to accommodate different product configuration. The operation sequence is controlled by a program, which is a set of instructions coded so that they can be read and interpreted by the system.	Remember	CO 1	CLO 2	AME533.02
4	Define Flexible Automation.	Flexible automation is an extension of programmable automation. A flexible automated system is capable of producing a variety of parts (or products) with virtually no time lost for changeovers from one part style to the next. There is no lost production time while reprogramming the system and altering the physical setup (tooting, fixtures, machine settings).	Remember	CO 1	CLO 1	AME533.01
5	Define the term Robot.	"A programmable multifunctional manipulator designed to move material, parts, or specialized devices through variable programmed motions for the performance of a variety of tasks."	Remember	CO 1	CLO 4	AME533.04
6	Define Articulated Robot.	An Articulated robot can be defined as a robot with rotary joint and these robots can range from simple two-jointed structures to systems with 10 or more interacting joints.	Remember	CO 1	CLO 4	AME533.04
7	Define Anthropomorphism.	Anthropomorphism is a phenomenon that describes the human tendency to see human-like shapes in the environment.	Remember	CO 1	CLO 1	AME533.01
8	What is Humanoid robot?	Humanoid robot is a robot with its body shape built to resemble the human body. The design may be for functional purposes, such as interacting with human tools and environments, for experimental purposes, such as the study of bipedal locomotion, or for other purposes.	Remember	CO 1	CLO 1	AME533.01

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
9	What is PTP control robot.	Point-to-point (PTP) control robot: is capable of moving from one point to another point. The locations are recorded in the control memory.	Remember	CO 1	CLO 3	AME533.03
10	Define CP control Robot.	Continuous-path (CP) control robot: with CP control, the robot can stop at any specified point along the controlled path.	Remember	CO 1	CLO 3	AME533.03
11	Define controlled path robot.	Controlled-path robot: the control equipment can generate paths of different geometry such as straight lines, circles, and interpolated curves with a high degree of accuracy.	Remember	CO 1	CLO 3	AME533.03
12	Describe controller.	Controller is much like the human brain which coordinates the muscles and all other parts of the body. It keeps track of time, the position of the joints, and the movements of the manipulator. It does this as per programme and with a list of instructions. The instructions are stored in the memory unit of controller.	Remember	CO 1	CLO 3	AME533.03
13	What is a manipulator?	The manipulator in the present case is the entire mechanism of the robot that provides movement of any degree of freedom. Therefore it consists of base, arm and gripper.	Understand	CO 1	CLO 3	AME533.03
14	Define Gripper.	The gripper is similar to the human hand. Just as the hand grasps the tool to perform the work, the gripper secures the robot's work piece while the operation is being performed. The shape of the gripper is determined by the task it has to perform.	Remember	CO 1	CLO 4	AME533.04
15	Define end effector.	In the robotic world it is generally understood that the end of the wrist is the end of the robot. The end effector is the correct name for the attachment that can be mounted to a bolting plate fitted to the wrist	Remember	CO 1	CLO 4	AME533.04
		UNIT-II				
1	What is rotation matrix?	Rotation matrix describes the mutual orientation between two coordinate frames; its column vectors are the direction cosines of the axes of the rotated frame with respect to the original frame. It represents the coordinate transformation between the coordinates of a	Remember	CO 2	CLO 5	AME533.05

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
		point expressed in two different frames (with common origin).				
2	Define kinematics of robotics	Kinematics pertains to the motion of bodies in a robotic mechanism without regard to the forces/torques that cause the motion. Since robotic mechanisms are by their very essence designed for motion,	Remember	CO 2	CLO 6	AME533.06
3	Define workspace or work envelope.	Most generally, the workspace of a robotic manipulator is the total volume swept out by the end-effector as the manipulator executes all possible motions. The workspace is determined by the geometry of the manipulator	Understand	CO 2	CLO 7	AME533.07
4	Describe forward kinematics.	The forward kinematics of manipulator is to find the position and orientation of the end-effector relative to the base given the positions of all of the joints and the values of all of the geometric link parameters.	Understand	CO 2	CLO 8	AME533.08
5	Describe inverse kinematics.	The inverse kinematics manipulator is to find the values of the joint positions given the position and orientation of the end- effector relative to the base and the values of all of the geometric link parameters.	Understand	CO 2	CLO 8	AME533.08
6	Define DH notation or Parameters.	The DH parameters were first appeared in 1955 to represent a directed line which is nothing but the axis of a lower pair joint.	Remember	CO 2	CLO 5	AME533.05
7	What is world coordinate system?	World coordinate system is a coordinate system whose origin is specified by a user. This system enables multiple robots to use a common coordinate system for position designation. By setting the origin of the facilities to that of the world coordinate system, you can set positions of different robots on the same coordinate system.	Remember	CO 2	CLO 6	AME533.06
8	What is joint coordinate system?	Joint coordinate system Joint coordinates specify the location of each axis in encoder counts. When the axes move, the optical encoders generate a series of alternating high and low electrical signals. The number of signals is proportional to the amount of axis motion; the controller counts the signals and determines how	Remember	CO 2	CLO 7	AME533.07

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		far an axis has moved.				
9	What is DC servo motor ?	The motor which is used as a DC servo motor generally have a separate DC source in the field of winding & armature winding. The control can be archived either by controlling the armature current or field current	Remember	CO 2	CLO 8	AME533.08
10	What is stepper motor ?	A stepper motor is just another digital device, more precisely a digital DC motor. Stepper or Stepper Motor allows you to select	Remember	CO 2	CLO 5	AME533.05
11	What is position sensor?	A position sensor is any device that permits position measurement. It can either be an absolute position sensor or a relative one position sensors can be linear, angular, or multi-axis.	Remember	CO 2	CLO 6	AME533.06
12	What is potentiometric sensor?	A potentiometric sensor is a type of chemical sensor that may be used to determine the analytical concentration of some components of the analyze gas or solution. These sensors measure the electrical potential of an electrode when no voltage is present.	Remember	CO 2	CLO 7	AME533.07
13	Explain resolver?	A resolver is a type of rotary electrical transformer used for measuring degrees of rotation.	Remember	CO 2	CLO 8	AME533.08
14	Explain encoder?	An encoder is a device, circuit, transducer, software program, algorithm or person that converts information from one format or code to another, for the purpose of standardization, speed or compression.	Remember	CO 2	CLO 5	AME533.05
15	What is velocity sensor?	A velocity or speed sensor measures consecutive position measurements at known intervals and computes the time rate of change in the position values.	Remember	CO 2	CLO 6	AME533.06
UNIT-III						
1	What is differential kinematics?	Differential Kinematics is the relations between motion (velocity) in joint space and motion (linear/angular velocity) in task space	Understand	CO 3	CLO 09	AME533.09
2	What is Jacobian matrix?	Each column of the Jacobian matrix defines the effect of the i-th joint on the end-effector velocity and it is divided in two terms. The first term considers the effect of on the linear velocity v, while the second one on the rotational velocity	Remember	CO 3	CLO 10	AME533.10

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
3	What is robot dynamics?	robot's dynamics provide a description of why things move when forces are generated in and applied on the system	Remember	CO 3	CLO 11	AME533.11
4	Define principle of virtual work?	Principle of Virtual Work A fundamental principle in mechanics is the principle of virtual work which describes the fact that configuration constraints actually define forces which do not perform work in the direction of the virtual displacements	Remember	CO 3	CLO 12	AME533.12
5	State Lagrangian formulation?	In the lagrangian formulation, the system's dynamic behavior is described in terms of work and energy using generalized coordinates. This approach is the extension of the indirect method. Therefore, all the workless forces and constraint forces are automatically eliminated in this method.	Remember	CO 3	CLO 09	AME533.09
6	State Newton-Euler formulation?	The Newton-Euler formulation is derived by the direct interpretation of Newton's Second Law of Motion, which describes dynamic systems in terms of force and momentum. The equations incorporate all the forces and moments acting on the individual robot links, including the coupling forces and moments between the links.	Understand	CO 3	CLO 10	AME533.10
7	What is kinematic Tree?	The connectivity of a robot mechanism can be described using a graph in which the nodes represent the bodies and the arcs represent the joints. If this graph does not contain any cycles, implying that it is a topological tree, then the robot mechanism is called a kinematic tree.	Remember	CO 3	CLO 11	AME533.11
8	Explain kinematic loop?	If the connectivity graph does contain cycles, then the robot mechanism contains kinematic loops, and is called a closed-loop system. The three dynamics algorithms described above do not work on closed-loop systems, although they can be used as components in a closed-loop dynamics algorithm. In general, closed-loop systems have more complicated dynamics than kinematic trees, and they require more sophisticated (and expensive) algorithms to calculate their dynamics.	Understand	CO 3	CLO 12	AME533.12

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
9	What is RNEA?	Recursive Newton-Euler algorithm (RNEA). This algorithm solves the inverse dynamics problem, and has a computational complexity of $O(n)$.	Remember	CO 3	CLO 09	AME533.09
10	What is ABA?	The articulated-body algorithm (ABA): This algorithm solves the forward dynamics problem, and has a computational complexity of $O(n)$.	Remember	CO 3	CLO 10	AME533.10
11	What is CRBA?	Composite-rigid-body algorithm (CRBA): This algorithm calculates the joint-space inertia matrix, H , and has a computational complexity of $O(n^2)$.	Remember	CO 3	CLO 11	AME533.11
12	Explain workspace control?	A different approach is to transform the dynamics and control problem into the task space, so that the control law is written in terms of the end effector position and orientation. We refer to this approach as workspace control.	Remember	CO 3	CLO 12	AME533.12
13	Differentiate fixed & floating bases in robotics?	A robot is said to have a fixed base if it is rigidly attached to a fixed support. An industrial robot arm is a good example of a fixed-base robot. If no part of the robot mechanism is fixed, then it is said to have a floating base.	Remember	CO 3	CLO 09	AME533.09
14	Define Motion through a sequence of points.	For given N path points, find an interpolating function through these points $N - 1$ order polynomial	Remember	CO 3	CLO 09	AME533.09
15	Define path.	locus of points in joint space (operational space) which the manipulator has to follow in the execution of the assigned motion.	Remember	CO 3	CLO 10	AME533.10
		UNIT-IV				
1	What is trajectory planning?	Trajectory planning is moving from point A to point B while avoiding collisions over time. This can be computed in both discrete and continuous methods. Trajectory planning is a major area in robotics as it gives way to autonomous vehicles. Trajectory planning is sometimes referred to as motion planning and erroneously as path planning.	Remember	CO 4	CLO 13	AME533.13

S.No	QUESTION	ANSWER	Blooms Level	CO	CLO	CLO Code
2	What are geometric constraints?	Geometric constraints are the constraints that can be expressed solely in terms of the robot joint angles, these include bounds on the joint angles, avoidance of self-collision and of collision with obstacles, etc. These constraints can thus be fully taken into account in the path planning step.	Remember	CO 4	CLO 14	AME533.14
3	What is role of optimization	Optimization comes into play when there are more than one path or trajectory that allow achieving the task while satisfying the constraints. It is then interesting to select the path or trajectory that optimizes a given objective.	Remember	CO 4	CLO 15	AME533.15
4	What is Joint space Trajectory?	Joint-space trajectory generation is in common usage in robotics to provide smooth, continuous motion from one set of n joint angles to another, for instance, for moving between two distinct Cartesian poses for which the inverse pose solution has yielded two distinct sets of n joint angles	Remember	CO 4	CLO 16	AME533.16
5	What is the role of obstacle avoidance ?	A complementary way to address the motion problem is obstacle avoidance. The objective is to move a vehicle towards a target location free of collisions with the obstacles detected by the sensors during motion execution	Remember	CO 4	CLO 13	AME533.13
6	What is the advantage of reactive obstacle avoidance?	The advantage of reactive obstacle avoidance is to compute motion by introducing the sensor information within the control loop, used to adapt the motion to any contingency incompatible with initial plans.	Remember	CO 4	CLO 14	AME533.14
7	What is slew motion?	Slew motion it is simplest type of motion. Robot is commanded to travel from one point to another at default speed. Performs without any calculations so it often leads to unanticipated results and wear on the robot joint	Remember	CO 4	CLO 15	AME533.15
8	What is joint interpolated motion?	Joint-interpolated motion requires the robot controller to calculate the time it will take each joint to reach its destination at the commanded speed.	Remember	CO 4	CLO 16	AME533.16
9	What is straight line interpolation	Straight-line interpolation motion: requires the end of the end effector to travel along a	Remember	CO 4	CLO 13	AME533.13

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	motion?	straight path determine in rectangular xy coordinates.				
10	What is Circular interpolation motion?	Circular interpolation motion: requires the robot controller to define the points of a circle in the workplace based on a minimum of three specified positions.	Remember	CO 4	CLO 14	AME533.14
11	What is an actuator?	It is a robot mechanism that enables the effector to execute an action	Remember	CO 4	CLO 15	AME533.15
12	What are hydraulic actuator?	In a hydraulic actuator, a cylinder or fluid-based motor uses the power of hydraulics to create mechanical action. The motion can be straight, rotating or oscillating.	Remember	CO 4	CLO 16	AME533.16
13	What are pneumatic actuator?	Pneumatic With a pneumatic actuator, a vacuum or compressed air is used to make energy into action. They are good for making a large linear or rotating motion with a small amount of pressure.	Remember	CO 4	CLO 13	AME533.13
14	What are mechanical actuators?	Using pulleys, gears, rails and chains, a mechanical actuator converts the rotating motion of physical objects into linear motion. One common example is rack and pinion steering systems.	Remember	CO 4	CLO 14	AME533.14
15	What is servo motor?	The servo motor is most commonly used for high technology devices in the industrial application like automation technology. It is a self-contained electrical device, that rotate parts of a machine with high efficiency and great precision.	Remember	CO 4	CLO 15	AME533.15
UNIT-V						
1	Define spot-welding robots.	A spot-welding robot has to carry the welding gun, which consists of the electrodes, the cables which are required to conduct the high current, and sometimes a water-cooling system for the electrodes.	Remember	CO 5	CLO 17	AME533.17
2	What are the characteristics of spray painting robots?	The spray painting robots has the following characteristics : (a) high level of manipulator dexterity, (b) large working volume for small-base manipulator, (c) compact writs,	Remember	CO 5	CLO 18	AME533.18

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		(d) small payload, and (e) low accuracy and repeatability.				
3	Define Interlock.	Interlocks provide means of preventing the work cycle sequence from continuing unless a certain or set of conditions are satisfied.	Remember	CO 5	CLO 19	AME533.19
4	Classify work part transport system used in in-line robot work cell.	There are 3 types of work part transport system used in in-line robot work cell. 1. Intermittent Transfer. 2. Continuous Transfer. 3.Non-Synchronous Transfer	Remember	CO 5	CLO 20	AME533.20
5	Define intermittent transfer.	The parts are moved in a start-and-stop motion from one station to another along the line. It is also called synchronous transfer since all parts are moved simultaneously to the next stop. The advantage of this system is that the parts are registered in a fixed location and orientation with respect to the robot during robot's work cycle.	Understand	CO 5	CLO 17	AME533.17
6	Define continuous transfer.	Work parts are moved continuously along the line at constant speed. The robot(s) has to perform the tasks as the parts are moving along. The position and orientation of the parts with respect to any fixed location along the line are continuously changing.	Understand	CO 5	CLO 18	AME533.18
7	Classify work cell control.	1. Sequence control 2. Operator interface 3. Safety monitoring	Understand	CO 5	CLO 19	AME533.19
8	Define input interlocks.	Input interlocks make use of signals sent from the components in the cell to the controller.	Understand	CO 5	CLO 20	AME533.20
9	Define Part Identification problem	It there are more than one type of parts, there will be a necessity to identify various parts by automated means, suct as optical techniques. magnetic techniques or limit switches that sense different sizes or geometry.	Understand	CO 5	CLO 17	AME533.17
10	How do you protect robot from its environment?	In applications such as spray painting. hot metal working conditions. abrasive applications. adhesive sealant	Understand	CO 5	CLO 18	AME533.18

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		applications, the robot has to be protected from possible adverse environment. (e.g. use of sleeves. long grippers).				
11	Define mobile work cell.	In this arrangement, the robot is provided with a means of transport, such as a mobile base, within the work cell to perform various tasks at different locations.	Remember	CO 5	CLO 19	AME533.19
12	What is non-synchronous transfer system.	This is a power and free system". Each work part moves independently of other parts. in a stop-and-go manner.	Remember	CO 5	CLO 20	AME533.20
13	Define repetitive work cycle.	If the sequence of elements in the work cycle is the same, and the elements consist of relatively simple motions, robots usually perform the work with greater consistency and repeatability than humans.	Remember	CO 5	CLO 17	AME533.17
14	What is Multi-shift operation.	A robot can replace two or three workers at a time in second or third shifts, thus they can provide a faster financial payback.	Remember	CO 5	CLO 18	AME533.18
15	Define Infrequent changeovers.	Robots' use is justified for long production runs where there are infrequent changeovers, as opposed to batch or job shop production where changeovers are more frequent.	Remember	CO 5	CLO 17	AME533.17

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