MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

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IQAC

MUST KNOW CONCEPTS

MKC

MECH

2020-21

Course Code & Course Name :16MEE14 Industrial Robotics

Year/Sem/Sec : IV/VII

S.No.	Term	Notation (Symbol)	Concept / Definition / Meaning / Units / Equation / Expression	Units
Unit-I : Fundamentals of Robot				
1.	Industrial Robot		Reprogrammable, multifunctional mechanical device performing tasks.	
2.	Manipulator		Machine having same function as of human being	
3.	Work envelope		Space within the robot manipulates its wrist	
4.	Pitch		Up and down movement of wrist	
5.	Roll		Rotation of wrist	
6.	Yaw		Right and Left movement of wrist	
7.	Actuator		Devices used to convert hydraulic energy to Mechanical Energy	
8.	Automation		Automation is a technology that is concerned with the use of mechanical electronic and computer based system in the operation and control of production.	
9.	Types of Automation		Fixed automation, programmable automation, flexible automation	
10.	Rule of robot		• do not harm human being • obey human being • protects itself from harm	
11.	Robot anatomy		It means study of structure of Robots	
12.	Types of robot anatomy		• polar • cylindrical • cartesian • jointed arm	
13.	Robot joints		• linear • rotational • twisting • revolving	
14.	Wrist		It is the set of rotary joints to which a robots end effector is attached.	

15.	Major components of robots		Manipulator, end effector, power source, controller, censors, actuator	
16.	General areas of robotics		Industrial, hobbyist, promotional, personal, military, educational, medical.	
17.	Work performed by the robot		• loading • unloading • palletizing • depalletizing	
18.	Advantages of robots		• greater flexibility • reprogram ability • adjustable kinematics • greater response time • improved product quality	
19.	Disadvantages of robots		• replacement of human labour • more unemployment • significant retraining costs	
20.	Processing application of Robot		• welding • painting • assembly • inspection	
21.	Offset		point of action for the tool mounted to the Robot tool plate	
22.	Types of Robot movements		• arm and body motion • wrist motion	
23.	4D jobs		• Dirty • Dangerous • Difficult • Dull	
24.	RIA definition of robot		Reprogrammable, multifunction manipulator designed to move materials, parts, tools or special devices through variable programmed motions for the performance of the variety of tasks.	
25.	Robot control techniques		• non servo control • servo control	
Unit-II : Robot Drive Systems and End Effectors				
26.	End-effector		Attachments at the wrist arm perform a task.	
27.	Grippers		Device to grasp objects	
28.	Stripping Device		Used to remove work piece from magnetic gripper	
29.	Compliance of a Robot		Displacement of the wrist in response to force	
30.	Feedback Devices		Potentiometer, Resolver, Encoder	
31.	Types of Drive Systems		Electric: Servo motors, Stepper motors Hydraulic actuators Pneumatic actuators	

32.	RCC		Remote Center Compliance	
33.	Linear hydraulic actuator		• single acting cylinder • double acting cylinder • double acting doublerod cylinder	
34.	Hydraulic rotary actuator		• Geared motor • Vane motor • Piston motor	
35.	Advantages of hydraulic actuator		• robust • self-lubricating • high efficiency	
36.	Disadvantages of hydraulic actuator		• expensive • noisy • high maintenance	
37.	Advantages of pneumatic actuator		• compact • cheapest • compressed air can be stored and conveyed easily over long distance	
38.	Disadvantages of pneumatic actuator		• more noise and vibration • not suitable for heavy load • if mechanical stops are used resetting the system can be slow	
39.	Advantages of electrical actuator		• widespread availability of power supply • no pollution of working environment • high power conversion efficiency	
40.	Disadvantages of electrical actuator		• poor dynamic response • larger and heavier motors must be used which is costly • conventional gear driven create backlash	
41.	Advantages of magnetic gripper		• pick up times are very fast • to handle metal parts with holes • require only one surface gripping	
42.	Disadvantages of magnetic gripper		• residual magnetism • side slippage • more than one sheet will be lifted by the magnet from a stack	
43.	Types of magnetic grippers		• electromagnetic grippers • permanent magnet grippers	
44.	Adhesive grippers		Which an adhesive substance performs the grasping action for handling fabrics and other lightweight material.	
45.	Limitations of adhesive grippers		• Adhesive substance losses is tackiness on repeated usage • Reliability is diminished with successive operations	

46.	Advantages of suction Cup grippers		• Requires only one surface of the part for grasping • Applies uniform pressure distribution • Lightweight gripper	
47.	Drive system used in the robot		• gears • pulley drive • rack and pinion • recirculating ball and screw • rotary drives	
48.	Advantages of open loop system		• simple • economical • easier to construct	
49.	Advantages of closed loop system		• the systems are accurate even in the presence of nonlinearities • less affected by noise	
50.	Uses of stepper motor		• Used for measured rotation • Can be held at a particular position of shaft	
Unit-III : Sensors and Machine Vision				
51.	Sensors		Device that detects information about the surroundings	
52.	Accuracy		Defined target point within work volume.	
53.	Precision		Closeness to the true value	
54.	Repeatability		Ability of the robot to position itself again and again	
55.	Spatial Resolution		Control resolution combined with mechanical inaccuracy	
56.	Control Resolution		capability of the robot's positioning system to divide the range of the joint into closed spaced points	
57.	Palletizing		Arranging materials on a pallet as per rules	
58.	Tactile Sensor		Indicates contact between themselves and some other solid objects	
59.	Proximity Sensor		Senses the presence or absence of the object without physical contact	
60.	Range sensor		Senses the distance of the object	
61.	Piezoelectric Materials		When stretched or compressed generates electric charges	
62.	Machine Vision		Image processing and Image analysis techniques	
63.	Frame Grabber		Device to store the digital image	
64.	Segmentation		Grouping areas of an image having similar characteristics	
65.	Region growing		Pixels are grouped in regions called grid elements	

66.	Thresholding		Binary conversion technique – each pixels are converted to binary values	
67.	Edge detection		Change of intensity in the pixels at the boundary or edges	
68.	Region Growing		It is a collection of segmentation techniques in which pixels are grouped in regions called grid elements based on attribute similarities.	
69.	Feature Extraction		In vision applications distinguishing one object from another is accomplished by means of features that uniquely characterize the object. A feature is a single parameter that permits ease of comparison and identification.	
70.	Types of Rotary encoders		• Incremental encoders • Absolute encoders	
71.	Transducer		A transducer is an electronic device that converts energy from one form to another.	
72.	Preprocessing		It deals with techniques such as noise reduction and enhancement of details.	
73.	Vision Applications		Object location, Object Properties, Spatial Relations, Action Monitoring	
74.	Capacitive technique advantages		• Wide Dynamic Range • Linear Response • Robust	
75.	Ultrasonic Sensors Applications		• Distance Measurement • Mapping	
Unit-IV : Robot Kinematics and Robot Programming				
76.	Robot Program		List of instruction to support the robot work cycle	
77.	Continuous path control		Entire route is specified by interpolation	
78.	Point to point control		Finite points are specified along the route	
79.	Kinematics		Study of relative motion between parts	
80.	Forward Kinematics		Determination of position and orientation knowing the joint angles	
81.	Reverse Kinematics		Determination of joint knowing the angles position and orientation	
82.	Teach Pendant		A small hand held control box to regulate robot movements	
83.	Versatile Algorithmic Language	VAL	Robotic language developed by Unimation. Inc. for PUMA series.	
84.	Servo Control Robot		Programmed by lead through and textual language methods	
85.	Straight line Interpolation		Computes the straight line path by sequence of addressable points	
86.	Circular Interpolation		Used to define a circle in the robot's workspace	

87.	Irregular smooth motion		Combination of straight, curved and back & forth motions	
88.	Manual Lead through programming		The programmer moves the manipulated wrist to teach	
89.	Degrees of Freedom		Freedom to move in space	
90.	RAIL		Robotic Automatix Incorp. Language	
91.	AML		A Manufacturing Language	
92.	MCL		Machine Control Language	
93.	AI		Artificial Intelligence	
94.	VML		Virtual Machine Language	
95.	SRL		Structured Robot Language	
96.	Teach Pendant mode of operations		Teach mode, test mode, repeat mode.	
97.	Transformation		• Pure translation • Pure Rotation • Combination of rotation and translation	
98.	Pure traslation		Frame moves without any change in its orientation	
99.	Articulated arm		3 DOF with RRR arm configuration	
100.	Joints driven modes		• Position control mode • Force control mode	
Unit-V : Implementation and Robot Economics				
101.	Payback period		Length of time required for net accumulated cash flow	
102.	Preventive Maintenance		Servicing the equipment at periodic intervals to reduce breakdown	
103.	Return on Investment	ROI	Determines the rate of return for the proposed project	
104.	Equivalent Uniform Annual Cost	EUAC	It converts investments and cash flows into equivalent uniform cash flows over life of project	
105.	Automated Guided Vehicle	AGV	Computer controlled driverless vehicles used for transporting materials	
106.	Vehicle Guidance Technology		Keeping AGV on a predefined path	
107.	Vehicle Management		Coordinating the unmanned vehicles	
108.	Vehicle Traffic Control		Minimizing interference between vehicles to prevent collusions.	
109.	Gantry Robot		Cartesian coordinate robots with the horizontal member supported at both ends are sometime called Gantry robots.	
110.	Rail Guided Vehicles	RGV	Motorised vehicles that are guided by a fixed rail system constitute a third category of material transport systems.	

111.	Robot purchase cost		The basic price of the robot equipped from the manufacturer with the proper options (excluding end effector) to perform the application.	
112.	Engineering costs		The costs of planning and design by the user company‘s engineering staff to install the robot.	
113.	Installation costs		This includes the labor and materials needed to prepare the installation site (provision for utilities, floor preparation, etc.).	
114.	Special tooling		This includes the cost of end effector, parts position and other fixtures and tools required to operate the work cell.	
115.	Miscellaneous costs		This covers the additional investment costs not included by any of the above categories (e.g. other equipment needed)	
116.	Direct labor cost		The direct labor cost associated with the operation of the robot cell. Fringe benefits are usually included in the calculation of direct labor rate, but other overhead costs are excluded.	
117.	Indirect labor cost		The indirect labor costs that can be directly allocated to thc operation of the robot cell. These costs include supervision, setup, programming	
118.	Maintenance cost		This covers the anticipated costs of maintenance and repair for the robot cell.	
119.	Applications of AGV		• Driverless train operations • Storage distribution system • Assembly line operation • FMS	
120.	Types of AGV vehicles.		• Towing vehicles • Unit load vehicles • Pallet trucks • Fork trucks • Light load Vehicles • Assembly line vehicles.	
121.	Types of maintenance		• Preventive maintenance • Emergency maintenance	
122.	Preventive maintenance		It involves the planned servicing at periodic intervals	
123.	Emergency maintenance		It is the case when the maintenance crew is called in to repair a robot that malfunctions or breaks down during regular operation.	
124.	Mean Time To Repair	MTTR	measure the average time of repairing the robot for each breakdown	
125.	Mean Time Between Failures	MTBF	average time of machinery will operate between breakdowns.	

Placement Questions				
126.	How many times are the hands of a clock at right angle in a day?		A. 22 B. 24 **C. 44** D. 48 Explanation: In 12 hours, they are at right angles 22 times. ∴ In 24 hours, they are at right angles 44 times.	
127.	A train moves with a speed of 108 kmph. Its speed in metres per second is :		A.10.8 B.18 **C.30** D.38.8 Explanation:108 kmph = 108*[5/18] m/sec = 30 m/s.	
128.	Determine the probability that a digit chosen at random from the digits 1, 2, 3, …12 will be odd.		Total no. of Digits = 12. Equally likely cases = 12. There are six odd digits. Probability = 6 / 12 = 1 / 2	
129.	In covering a distance of 40 km, Kamlesh takes 2 hours more than Pankaj. If Kamlesh doubles his speed, then he would take 1 hour less than Pankaj. Then what is Kamlesh's speed?		A. 11 kmph **B. 5 kmph** C. 9 kmph D. 6 kmph Answer:B Explanation: Let Kamlesh's speed be x km/hr. Then, `40/x - 40/(2x) = 4` 8x = 40 x = 5 km/hr	
130.	Solve the equation x+34=82		A. 58 **B. 48** C. 55 D. 60 Explanation: x=82-34=48	
131.	An accurate clock shows 8 o'clock in the morning. Through how may degrees will the hour hand rotate when the clock shows 2 o'clock in the afternoon?		A.360. **B.180** C.90 D.60 Answer: B) 180 Explanation: Angle traced by the hour hand in 6 hours=(360/12)*6	
132.	Excluding stoppages, the speed of a bus is 54 kmph and including stoppages, it is 45 kmph. For how many minutes does the bus stop per hour?		A. 9 **B. 10** C. 12 D. 20	

133.	Find the no., when 15 is subtracted from 7 times the no., the result is 10 more than twice of the number		Let the number be x. 7x -15 = 2x + 10 => 5x = 25 => x = 5	
134.	If 0.75: x :: 5:8, then x is equal to:		A.1.12 B.1.16 **C.1.20** D.1.30 Explanation:(x * 5) = (0.75 *8) X=6/5 = 1.20	
135.	Today is Monday. After 61 days, it will be :		A. Tuesday B. Monday C. Sunday **D. Saturday** Answer: D) Saturday Explanation: Each day of the week is repeated after 7 days. So, after 63 days, it will be Monday. After 61 days, it will be Saturday.	
136.	Adam can do a job in 15 days; Eve can do the same job in 20 days. If they work together for 4 days, what fraction of job is incomplete?		Adam can do 1/15 of the job per day Eve can do 1/20 of the job per day If they work together they can do 7/60 of the work together Remaining job 1 - 7/60 = 32/60 = 8/15	
137.	Which one of the following is not a prime number?		A.31 B. 61 C. 71 **D. 91** Explanation: 91 is divisible by 7. So, it is not a prime number.	
138.	Find c, if 5c - 2 = 33		**A. 7** B. 9 C. 11 D. 13 Explanation: We add 2 to both sides and get 5c-2+2=33+2, or 5c=35. We divide both sides by 5 to get c=7.	
139.	A person crosses a 600 m long street in 5 minutes. What is his speed in km per hour?		A. 3.6 **B. 7.2** C. 8.4 D. 10 Explanation: Speed = 600/ 5 x 60 m/sec. = 2 m/sec. = 2 x 18/5km/hr =7.2 km/hr	

140.	A and B can do a piece of work in 4 days, while C and D can do the same work in 12 days. In how many days will A, B, C and D do it together?		A, B, C and D will together take ¼ + 1/12 = 4/12 = 1/3. 3 days to complete the work.	
141.	The average of five numbers is 27. If one number is excluded, the average becomes 25. The excluded number is?		A.25 **B.35** C.45 D.55 Answer:B Explanation: (27*5)-(25*4) 135-100 35	
142.	The maximum gap between two successive leap year is?		A.4 **B.8** C.2 D.1 Answer: B) 8 Explanation: This can be illustrated with an example. Ex: 1896 is a leap year. The next leap year comes in 1904 (1900 is not a leap year).	
143.	A guy bought 10 pencils for Rs. 50 and sold them for Rs. 60.What is his gain in terms of percentage?		A. 10% B. 5% **C. 20%** D. 12% Answer:C Explanation: `"Gain%"=("Gain"/"C.P")*100=20%`	
144.	Two trains starting at the same time from 2 stations 200 km apart and going in opposite direction cross each other at a distance of 110 km from one of the stations. What is the ratio of their speeds?		In the same time, they cover 110 km and 90 km respectively. For the same time, speed and distance is inversely proportional. So ratio of their speed = 110:90 = 11: 9	
145.	In 100 m race, A covers the distance in 36 seconds and B in 45 seconds. In this race A beats B by:		**A. 20m** B. 25m C. 22.5m D. 9m Explanation: Distance covered by B in 9 sec. = (100/45)*9m = 20m	
146.	Half percent, written as a decimal, is		A.0.2 B.0.02 **C.0.005** D.0.05	

			Answer: C Explanation: As we know, 1% = 1/100 Hence, (1/2)% = (1/2 * 1/100) = 1/200 = 0.005	
147.	A pump can fill a tank with water in 2 hours. Because of a leak, it took 2.5 hours to fill the tank. The leak can drain all the water of the tank in:		A. 4 1/3 Hours B. 7 Hours C. 8 Hours **D. 10 Hours** Explanation: Work done by the leak in 1 hour = $\left(1\frac{2}{5}\right)=\frac{1}{10}$. ∴ Leak will empty the tank in 10 hrs.	
148.	If a number is chosen at random from 1 to 100, then the probability that the chosen number is a perfect cube is		We have 1,8,27 and 64 as perfect cubes from 1 to 100. Thus, the probability of picking a perfect cube is 4/100 = 1/25	
149.	Three times the first of three consecutive odd integers is 3 more than twice the third. The third integer is:		A. 9 B. 11 C. 13 **D. 15** Explanation: Let the three integers be x, $x + 2$ and $x + 4$. Then, $3x = 2(x + 4) + 3 \Leftrightarrow x = 11$. ∴ Third integer = $x + 4 = 15$.	
150.	Find the number, when 15 is subtracted from 7 times the number, the result is 10 more than twice of the number		**A. 5** B. 15 C. 7.5 D. 4 Explanation: Let the number be x. 7x -15 = 2x + 10 => 5x = 25 => x = 5	