Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: Robotics		Course Code:15MC62T
Mode (L:T:P) : 4:0:0	Credits:4	Core/ Elective: Core
Type of Course: Lectures & Student Activities		Total Contact Hours: 52
CIE= 25 Marks		SEE= 100 Marks

Pre-requisites: Knowledge of Theory of machines, Microprocessor, Manufacturing Science, Engineering Graphics

Course Objectives: Understand the anatomy, programming and applications of robot

Course Outcome: At the end of the course, the student should be able to

1. Explain the fundamentals of robotics
2. Explain the basic elements of robot system
3. Explain the vision systems in robotics
4. Explain the basic commands in robot programming
5. Explain the artificial intelligence in robot
6. Explain the industrial applications of robot .

Course Outcome		Cognitive Level	Linked with PO	Teaching Hours
CO1	Explain the fundamentals of robotics	*U*	2	8
CO2	Explain the basic elements of robot system	*U*	2	12
CO3	Explain the vision systems in robotics	*U*	2	8
CO4	Explain the basic commands in robot programming	*U*	2	8
C05	Explain the artificial intelligence in robot	*U*	2	8
C06	Explain the industrial applications of robot	*U*	2	8
		Total sessions		**52**

Legend: R; Remember, U: Understand A: Application

Mapping of Course Outcomes with Program Outcomes

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Robotics	-	**3**	-	-	-	-	-	-	-	-

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.
If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3
If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2
If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course Content and Weightage For SEE

Unit No	Unit Name	CO	Hour	Marks allocated for different Cognitive level Questions			Marks weightage (%)
				R	U	A	
1	Fundamentals of Robotics	1	8	-	25	-	17.24
2	Basic elements of Robot system	2	12	-	30	-	20.68
3	Vision systems in Robotics	3	8	-	20	-	13.79
4	Programming in Robot	4	8	-	25	-	17.24
5	Artificial intelligence in Robot	5	8	-	25	-	17.24
6	Applications of Robot	6	8	-	20	-	13.79
	Total		52	145 Marks			100

Contents

Unit-I

Fundamentals of Robotics

Introduction to Robots, Definition of Robot, Robot configurations (Polar, Cylindrical, Cartesian coordinate, Jointed arm) Basic Robot motions(Vertical motions, Radial motions, Rotational motions, Pitch motions, Types mechanical joints used in Robotics system(Linear Joint, Rotational Joint, Twisting Joint, Revolving Joint), Notation Scheme for designating Robot configurations, degrees of freedom, Robot specification (Work envelope, Load carrying capacity, Speed of movement, Accuracy, Repeatability, Spacial resolution),Basic elements of Robot system (Base, Manipulator arm, End Effectors, Sensors and transducers, Actuators and Drives, Control systems) Advantages and industrial applications

8 **Hours**

Unit-II

Basic elements of Robot system

Base, Manipulator arm, End Effectors(grippers: (mechanical: pivoting movement, linear or translation movement), mechanical gripper actuation: linkage, rack and pinion, cam and screw type actuation, vacuum cups, magnetic grippers and adhesive grippers, tools as end effectors, consideration in gripper selection and design),Sensors and transducers (tactile sensors, touch sensors , force sensors, force sensing wrist, joint sensing, tactile array sensors, proximity sensors and range sensors(Proximity sensors using reflected light against a sensor array, users of sensors(safety monitoring, interlocks in work cell control , part inspection for quality control, determining positions of objects in robot cell. Actuators and drives (pneumatic and hydraulics and electric (stepper motor, DC and AC servo motors), power transmission system gears, power screws, Control systems: (on/off, proportional integral, derivative, PI, PD and PID controllers.)

12 Hours

Unit-III

Vision systems in Robotics

Introduction, process of vision system, low level vision: sensing and digitizing(vision camera, illumination techniques(front lighting and back lighting), analog to digital signal conversion ,image storage),pre-processing (noise reduction or smoothing, enhancement), high level vision (segmentation, tresholding ,region growing, edge detection, object description, object recognition and object interpretation), applications (inspection, identification and navigation).

8 Hours

Unit-IV

Programming in Robot

Introduction, methods of robot programming, lead through method(powered lead through, manual lead trough),Textual robot language, types languages:-WAVE, AND AL, VAL, AML, MCL, RAIL, HELP, JARS, RPL, AUTOPASS, modes of software operation, monitor mode, run or executive mode and editor mode, VAL system, Introduction to VAL, representation of robot location, language elements and functions: constant variables and other data objects(constant and variables, aggregate and location variables),motion commands(MOVE and related statements, speed control, definition of points in the work place, paths and frames)End effectors and sensor commands(end effector operation, sensor operation, react statement).

8 Hours

Unit-V

Artificial intelligence in Robot

Introduction, AI techniques, Knowledge representation, Problem representation and problem solving, Search techniques in problem solving, LISP programming, AI and Robotics, simple programs using LISP.

8 Hours

Applications of Robot

Robot Material Handling(Pick and place Robot, Robots in palletizing and related operations, Robots in processing operations(Spot Welding, Continuous Arc Welding, Spray Coating) Robots in automated assemblies, Robots in automated inspections

8 Hours

Reference Books:

1. Industrial Robotics – Mikell P. Groover et al.
2. Robotic Engineering – Richard D. Klafter et al.
3. Robotics technology and flexible automation – S.R. DEB and S.DEB

e-Reference

1. http://www.g-w.com/pdf/sampchap/9781605253213_ch02.pdf
2. **http://www.mech.sharif.ir/c/document_library/get_file?uuid=72d4fa8c-2ce0-444f-aebf-f7735c5c51ee&groupId=14040**
3. **http://www.roboticsbible.com/category/industrial-robotics/ind-robo-grippers**
4. **https://en.wikipedia.org/wiki/Vision_Guided_Robotic_Systems**
5. **http://www.roboticsbible.com/machine-vision-system.html**
6. **https://www.quora.com/What-programming-languages-are-used-in-robotics**
7. **http://faculty.kfupm.edu.sa/COE/mayez/ps-coe484/core/chap6.pdf**
8. **http://www.slideshare.net/ranger7721/robotics-artificial-intelligence-3536905**
9. **http://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_tutorial.pdf**
10. **http://www.slideshare.net/anmolseth520/robotics-30421670**
11. **https://www.robots.com/applications**
12. **http://blog.robotiq.com/bid/52886/Industrial-robots-5-most-popular-applications**

Student Activity

Activity No	Description of the Student Activity
1	Prepare a power point presentation on applications of robot beyond the curriculum

Note:

1. Group of max four students should do the above activity or any other similar activity related to the course COs and get it approved from concerned Teacher and HOD.
2. No group should have activity repeated or similar
3. Teacher should asses every student by using suitable **Rubrics** approved by HOD

Sample Rubrics

Dimension	Exemplary	Accomplished	Developing	Beginning	Roll No. of the Student				
	5/4	3	2	1	1	2	3	4	5
Organization	Information presented in logical, interesting sequence	Information in logical sequence	Difficult to follow presentation--student jumps around	Cannot understand presentation--no sequence of information	Ex: 2				
Subject Knowledge	Demonstrates full knowledge by answering all class questions with explanations and elaborations	At ease with expected answers to questions but does not elaborate	Uncomfortable with information and is able to answer only rudimentary questions	Does not have a grasp of the information. Cannot answer questions about subject	4				
Graphics	Explain and reinforce screen text and presentation	Relate to text and presentation	Occasionally uses graphics that rarely support text and presentation	Uses superfluous graphics or no graphics	5				
Oral Presentation	Maintains eye contact and pronounces all terms precisely. All audience members can hear	Maintains eye contact most of the time and pronounces most words correctly. Most audience members can hear presentation	Occasionally uses eye contact, mostly reading presentation, and incorrectly pronounces terms. Audience members have difficulty hearing	Reads with no eye contact and incorrectly pronounces terms. Speaks too quietly	3				
Total Score=2+3+4+5=14/4=3.5=4									

Institutional Activity

Activity No	Description of the Institutional Activity
1	Organize seminar, workshop, lecture from eminent person in the robot and AI domain
2	Organize industrial visit practicing FMS
3	Motivate student to take case study on future robotic technology

Course Assessment Pattern

Particulars			Max Marks	Evidence	Course outcomes
Direct Assessment	**CIE**	Three tests (Average of three tests)	20	Blue books	1,2,3,4,5,6
		Student Activity	05	Student Activity Sheets	1,2,3,4,5,6
	SEE	End of the course	100	Answer scripts at BTE	1,2,3,4,5,6
Indirect Assessment	**Student Feedback on course**	Middle of the course		Feedback forms	1, 2&3
		End of the course		Feedback forms	1,2,3, 4, 5&6

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Note to IA verifier*: *The following documents to be verified by CIE verifier at the end of semester

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks and should be assessed on RUBRICS
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods.

Model Question Paper (CIE)

Date and Time	Semester	Course	Max Marks
1Test(6 th week of sem) 10-11 Am	VI SEM	**Robotics**	20
	Year: 2017-18	Course code:15MC62T	

Name of Course coordinator : **Units:1,2 Co: 1,2**

All questions carries equal marks

Question No	Question	CL	CO	PO
1	Explain with neat sketch polar configuration of a robot OR Explain with neat sketch Jointed arm configuration of a robot	U	1	2
2	With a sketch label the basic elements of robot OR Explain with sketch revolving and twisting joint	U	1	2
3	Explain with sketch the actuation of a gripper by using cam OR Explain the working of magnetic grippers	U	2	2
4	With sketch explain force sensing wrist OR Explain PID controllers	U	2	2

Model Question Paper
VI Semester Diploma in Mechatronics Engineering
Robotics
Instructions: Answer any six questions from part A and Seven full questions from part B

PART-A

Answer any six questions. **5X6=30 marks**

1. Explain the basic robot motions
2. Explain the various tools used as end effectors
3. Explain tactile array sensors
4. Explain analog to digital signal with respect to vision system
5. Explain manual lead through method of robot programming
6. Explain speed control statements in VAL language
7. Explain MIN commands in LISP programming
8. Explain problem solving technique in AI
9. Explain Robots in automated assemblies

PART- B

Answer any seven full questions. **10X7=70M**

1 a) Explain with neat sketch Cartesian coordinate configuration of a robot
b) Explain with sketch types of joints used in robots

2 a) Explain work volume & precision of movement
b) Explain with sketch pitch, roll and yaw motions

3 a) Explain with sketch the actuation of a gripper by using rack and pinion
b) Explain the factors considered in selection and design of grippers

4 a) Explain ON/OFF control system used in robot
b) Explain integral controller

5 a) Explain sensor used in determining position of an object in the robot cell
b) Explain how image is stored in vision system

6 Explain the enhancement in digital image processing and scene analysis

7 a) Explain aggregates and location variables in VAL language
b) Explain paths and frames in VAL

8 a) Explain move and related statements in VAL language
b) Explain problem representation technique in AI

9 a) Explain CAR commands in LISP programming
b) Explain DEFUN commands in LISP programming

10 a) Explain Robots in palletizing and related operations
b) Explain Robots in Spot Welding

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Model Question Bank
VI Semester Diploma in Mechatronics Engineering
Robotics

Unit -1
Fundamentals of Robotics
Cognitive level- Understanding

1. Explain with neat sketch polar configuration of a robot
2. Explain with neat sketch cylindrical configuration of a robot
3. Explain with neat sketch cartesian coordinate configuration of a robot
4. Explain with neat sketch jointed arm configuration of a robot
5. Explain the basic robot motions
6. Explain with sketch types of joints used in robots
7. Explain the notational scheme for designating robot configuration
8. With a sketch explain six degrees of freedom in a robot motion
9. Explain work volume & precision of movement
10. Explain speed movement& load carrying capacity
11. Explain spatial resolution, accuracy and repeatability
12. With a sketch explain the basic elements of robot
13. Explain with sketch linear and rotational joint
14. Explain with sketch revolving and twisting joint
15. Explain with sketch vertical, radial and rotational motions
16. Explain with sketch pitch, roll and yaw motions

Unit –ii
Robots end effectors and sensors
Cognitive level- understanding

1. Explain with sketch mechanical grippers for pivoting movement
2. Explain with sketch mechanical grippers for linear or translation movement
3. Explain with sketch the actuation of a gripper by using linkages
4. Explain with sketch the actuation of a gripper by using cam
5. Explain with sketch the actuation of a gripper by using rack and pinion
6. Explain with sketch the actuation of a gripper by using screw actuation
7. Explain the working principle of vacuum cup grippers
8. Explain the working of magnetic grippers
9. Explain the working of adhesive grippers
10. Explain the various tools used as end effectors
11. Explain the factors considered in selection and design of grippers
12. Explain tactile sensors used in robot
13. Explain touch sensors used in robot
14. Explain force sensors used in robot
15. With sketch explain force sensing wrist
16. Explain joint sensing in robot
17. Explain tactile array sensors
18. Explain with sketch proximity sensor using reflected light against a sensor array
19. Explain sensor used for safety monitoring in robot
20. Explain sensor used in interlocks in workcell control

21. Explain sensor used in part inspection in quality control
22. Explain sensor used in determining position of an object in the robot cell
23. Explain on/off control system used in robot
24. Explain proportional controller
25. Explain integral controller
26. Explain derivative controller
27. Explain pi controllers
28. Explain pd controllers
29. Explain pid controllers

Unit –iii

Vision systems in robotics

Cognitive level- understanding

1. Explain sensing and digitizing function in machine vision
2. Explain the working principle of vidicon camera
3. Explain back lighting and front lighting illumination techniques with sketch used in vision system
4. Explain analog to digital signal with respect to vision system
5. Explain how image is stored in vision system
6. Explain noise reduction or smoothing function
7. Explain the enhancement in digital image processing and scene analysis
8. Explain segmentation in high level vision
9. Explain tresholding in high level vision
10. Explain edge detection in high level vision
11. Explain region growing in high level vision
12. Explain object description in high level vision
13. Explain object recognition in high level vision
14. Explain object interpretation in high level vision
15. Explain the robot vision system in inspection
16. Explain identification of object
17. Explain navigation of robot

Unit-iv

Robot languages

Cognitive level- understanding

1. Explain powered lead through method of robot programming
2. Explain manual lead through method of robot programming
3. Explain teach pendant method of robot programming
4. Explain constants and variable in VAL language
5. Explain aggregates and location variables in VAL language
6. Explain move and related statements in VAL language
7. Explain speed control statements in VAL language
8. Explain definition of points in work place using VAL
9. Explain paths and frames in VAL
10. Explain end effector operation

11. Explain sensor operation
12. Explain react statement

Unit-v
Artificial intelligence
Cognitive level- understanding

13. Explain knowledge representation technique in ai
14. Explain problem representation technique in ai
15. Explain problem solving technique in ai
16. Explain search technique in problem solving
17. Explain PLUS commands in lisp programming with example
18. Explain DIFFERENCE command in lisp programming with example
19. Explain ADD commands in lisp programming with example
20. Explain QUOTIENT commands in lisp programming with example
21. Explain MIN commands in lisp programming with example
22. Explain PLUS commands in lisp programming with example
23. Explain SQRT commands in lisp programming with example
24. Explain CAR commands in lisp programming with example
25. Explain CDR commands in lisp programming with example
26. Explain APPEND commands in lisp programming with example
27. Explain LIST commands in lisp programming with example
28. Explain CONS commands in lisp programming with example
29. Explain DEFUN commands in lisp programming with example
30. Explain SCTQ commands in lisp programming with example
31. Explain COND commands in lisp programming with example
32. Explain PLUS commands in lisp programming with example

Unit-vi
Applications of robot
Cognitive level- understanding

33. Explain pick and place robot
34. Explain robots in palletizing and related operations
35. Explain robots in spot welding
36. Explain robots in continuous arc welding
37. Explain robots in spray coating
38. Explain robots in automated assemblies
39. Explain robots in automated inspections