INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION FORM

Department	:	**MECHANICAL ENGINEERING**			
Course Code	:	**A70355**			
Regulations	:	**R15-JNTUH**			
Course Title	:	ROBOTICS			
Course Structure	:	Lectures	Tutorials	Practical's	Credits
		4	-	-	4
Course Coordinator	:	Mr. A. Anudeep Kumar, Assistant Professor, Department of Mechanical Engineering.			
Team of Instructors	:	Mr. A. Anudeep Kumar, Assistant Professor, Department of Mechanical Engineering.			

I. Course Overview:

This course makes understand the underline concepts used in design and building robot and make it working. The course covers kinematics and dynamics of motion robot arms. It covers feedback control systems, sensors, programming to make robotic work finally it undertakes to explain work in principles involved in industrial applications of robot.

II. Prerequisites:

Level	Credits	Periods	Prerequisite
UG	4	4	Engineering mechanics, Kinematics of machinery, Strength of Materials, Mathematics-II.

III. Course Assessment Methods:

Marks Distribution:

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective type and Objective type tests. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each midterm exam shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks with duration of 20minutes. It consists of 10 Multiple choice and 10 fill in the blanks. The student has to answer all the questions and each carries halfmark. First midterm examination shall be conducted for the first 2 ½ units of syllabus and second midterm examination shall be conducted for the remaining 2 ½ units. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course reason whatsoever, will get zero marks(s).	75	100

IV. Evaluation Scheme:

S. No.	Component	Duration	Marks
1	I Mid Examination	80 Minutes	20
2	I Assignment		5
3	II Mid Examination	80 Minutes	20
4	II Assignment		5
consider as average of above two mid examinations			
5	External Examination	3 hours	75

V. Course Objectives:

The objective of the course is to enable the student in:

I. Understanding basic concepts of robots and their development.
II. Knowledge of various configuration of robots used in industry, role of robots in industrial automation.
III. Analyze the forces acting on gripper and selection and design of grippers, actuators and sensors.
IV. Transformation of motion of robot endeffector with Denavit and Hartenberg parameters.
V. Apply Euler-Lagrange and Newton-Euler equations of motion are used for finding force and torque required at each of the joint actuators.

VI. Course Outcomes:

At the end of this course, the student will have ability to:

1. Configure various robots with the help of given or required motions.
2. Design robot on with various links, mechanisms and end effectors.
3. knowledge and analysis skills associated with trajectory planning.
4. Apply motion of end effector from one position to another position by means of D-H matrix.
5. Calculate the Jacobian for serial and parallel robot.
6. knowledge of the singularity issues associated with the operation of robotic systems.
7. Calculate the requirement of actuators for moving the robotic arms from position to another.
8. knowledge and skills associated with robot control.
9. Develop student’s skills in perform kinematics analysis of robot systems.
10. Apply robot for various applications in manufacturing.
11. Knowledge in various robot structures and their workspace.
12. Develop student’s skills in performing spatial transformations associated with rigid body motions.
13. Calculate the forward kinematics and inverse kinematics of serial and parallel robots.
14. knowledge of the path planning for a robotic system.

VII. How course outcomes are assessed:

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge:** Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering.	H	Assignments and Tutorials
PO2	**Problem Analysis:** An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.	S	Tutorials
PO3	**Design/ Development of Solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	S	Exams
PO4	**Conduct investigations of complex problems:** To design and conduct research-oriented experiments as well as to analyze and implement data using research methodologies.	S	Mini Projects
PO5	**Modern tool usage:** An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.	N	----
PO6	**The Engineer and society:** To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	S	Mini Projects
PO7	**Environment and society**: To understand impact of engineering solutions in the societal context and demonstrate the knowledge for	S	------
PO8	**Ethics:** An understanding responsibilities and implementation of professional and Ethical	N	------
PO9	**Individual and Team work:** To function as an effective individual and as a member or leader in Multi- disciplinary environment and adopt in diverse teams.	H	Assignments, Tutorials
PO10	**Communication:** An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society.	N	-----
PO11	**Project management and finance**: An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.	H	Mini Projects
PO12	**Life-Long learning**: Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	N	------

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional Skills**: To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	H	Lectures, Assignments
PSO 2	**Design/Analysis:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	S	Projects
PSO 3	**Successful and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become Technocrats.	H	Guest Lectures

N - None **S – Supportive** **H – Highly Related**

VIII. SYLLABUS:

UNIT-I

Introduction, Automation and Robotics: An over view of Robotics-classification by coordinate system and control systems.

Components of the Industrial Robotics: Degrees of freedom – End effectors: Mechanical gripper – Magnetic – Vacuum cup and other types of grippers – General Consideration on gripper selection and design, Robot actuators and sensors.

UNIT-II

Motion Analysis: Basic rotation matrices – Composite rotation matrices – Euler Angles – Equivalent Angle and axis – Homogeneous transformation – Problems.

Manipulator Kinematics: D-H notations – joint coordinates and world coordinates – Forward and inverse kinematics – problems.

UNIT-III

Differential Kinematics: Differential Kinematics of planar and spherical manipulators –Jacobians – problems.

Robot Dynamics: Lagrange – Euler formulations – Newton-Euler formulations – Problems on planar two link manipulators.

UNIT-IV

Trajectory Planning: Joint space scheme – cubic polynomial fit – Avoidance of obstacles – **Types of motion:** Slew motion – joint interpolated motion – straight line motion – problems.

Robot actuators and Feedback components**:** Actuators: Pneumatic.

UNIT-V

Robot Application in Manufacturing: Material handling – Assembly and Inspection-Work cell design, work volume, Robot screen.

IX. TEXT BOOKS:

T1. M.P. Groover, "Industrial Robotics", Pearson Edu.

T2. Introduction to Robotic Mechanics and Control / JJ Craig / Pearson / 3rd edition.

X. REFERENCES:

R1. Robotics / Fu K S / McGraw Hill.

R2. Robotics Engineering / Richard D. Klaftez / Prentice Hall.

R3. Robot Analysis and intelligence / Asada and Slotine / Wiley Inter Science.

R4. Robot Dynamics & Control / Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pvt. Ltd.

R5. Robotics and Control / Mittal R K & Nagrath I J / TMH.

XI. Course Plan:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1	**Describe** various stages of Robot, development	**UNIT-I** History of development of robots in chronological order	T1: 1.2
2-3	List various types of Robots used in industry	Robotic classification by co-ordinate and control system	T1:1.3, R1:1.2
4	Illustrate structure of Robotics	Components of robotics	T1:1.4,R1:1.4
5	Explain automation and Robotics as apply to industry	Automation and robotics. Need for this technologies in manufacture.	T1:1.5
6	Explain degrees of freedom	Description of various robots with degrees of freedom	T1:1.6
7	Categorize various types of end effectors	Description of various types of endeffctors	T1:1.7
8-10	Explain for function of gripper &	Illustration of gripper	T2:1.8

	classify various types of gripper	mechanism course analysis	
11-13	Explain considerations in selection & design of gripper.	Requirement of gripper selection features	T2:1.9
14-15	Categorize various types of sensors	Description and function of various types of sensors.	T1:1.10
16-18	Explain Rotation matrices about X Y & Z axis.	**UNIT-II** Derivation of transformation matrix about X Y and Z axis. Composite rotation matrix.	T1:2.1
19-21	Describe Euler angles & equivalent angles about axis.	Problems derivation of composite matrix using Euler angles,	T1:2.2
22-23	Describe Homogeneous transformation matrix	Problem related to transformation in various axis.	T1:2.3
24-25	Explain D.H Rotation	Description of D-H Variables, Describe procedure for forward kinematic motion analysis.	T2:2.4
26-28	Describe kinematics of Robotics in forward and reverse using matrix.	Problem related to D-H and matrix.	T1:2.5
29-30	Explain Differential kinematics.	**UNIT-III** Derivational of transformation matrix for small; incremental motion	T1:3.1
31-34	Explain jacobian matrix	Problems on differential motion derivation of jacobian matrix for various configuration	T1:3.2
35-38	Describe Dynamic equation of robot or motion for different configurations	Derivation of Lagrange-Euler equation	T1:3.3
39-41	Explain various terms used in Newton-Euler formulation	Solution of problems different configuration of robots	T1:3.4
42-44	Describe various types of motion of end effector in space	**UNIT-1V** Joint space motion for both straight line and point to point motions slew motion interpolated motion.	T2:4.1
45-48	Explain polynomial equation of fit for robot motion	Explanation of polynomial equation for various types of motion and solution of problems in various types of trajectories.	T2:4.2
49-52	Describe various types of actuators	Description of functional aspects of each actuator and application	T2:4.3
53-54	Explain role of robots in manufacture	Function wise description of various configuration of robots for different application.	T2:4.4
55-57	Describe various configuration of robots for manufacturing assembling inspection purpose	**UNIT V** Requirement and function of each robot for different applications	T1:5.1
58-61	Explain robot cell design	In application in different manufactures applications to be describe.	T1:5.2

61-62	Describe work volume and robots screen concepts	Explanation and description of work volume of a robot.	T1:5.3

XII. MAPPING COURSE OBJECTIVES LEADING TO ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES.

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H				H				H				H		H
II		H	S		H		S			S		S	H		
III	H			S	H			H				S	H		H
IV		H				H			S		H				
V	H		S		H		H					S			H

N = None **S = Supportive** **H = Highly related**

XIII. MAPPING COURSE OUTCOMES LEADING TO ACHIEVEMENT OF THE PROGRAM OUTCOMES PROGRAM SPECIFIC OUTCOMES.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H								S		S		H		H
2		H	S		H							S		S	
3	H						S		S	H			H		
4			S		H						S		H		H
5	S					S			S			S		S	S
6															
7		S		H			H			S				H	
8	H				S				H			S			S
9			H			S		H			S		H		
10		S												S	
11					S			H			S			H	
12	S			H					S	H			H		H
13		S			H			S			H			S	
14	H			S			H					S			

N = None **S = Supportive** **H = Highly related**

Prepared By:
Mr. A. Anudeep Kumar, Assistant Professor

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