INSTRUCTION DIVISION

FIRST SEMESTER 2015-2016

Course Handout (Part II)

Date: 03/08/2015

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. **: ME G511**
Course Title **: MECHANISMS & ROBOTICS**
Instructor-in-charge **: B K ROUT**

Scope and Objective: This course is intended to provide a comprehensive knowledge of the technology related to robotics. The necessity of human like machines to replace human beings from the work-sites have been long felt for a large variety of reasons. The field of robotics has emerged as one of the important engineering areas of the future.

The course will develop overall background of the student in interdisciplinary robotic technology with emphasis on mechanical aspects. Mechanisms which can be used in robots, their characteristics, kinematic and dynamic analysis and design will be discussed in detail along with the issues, applications and implementation principles of industrial robotics.

Text Book:

(T) Mittal R. K. & Nagrath, I. J., "*Robotics and Control"*, TMH, 2003 (Reprint 2010 or later).

Reference Books:

(R1) Groover, M. P., et al., "*Industrial Robotics*", MGHISE, 1986.
(R2) Fu, K. S., et al., *Robotic: Control, Sensing, Vision & Intelligence*, MGHISE, 1987.
(R3) Robert J., Schilling, *Fundamentals of Robotics: Analysis and Control*, Prentice Hall, NJ, 2002.

Lecture Plan:

Lecturer No.	Learning Objectives	Topics to be covered	Reference Chap./Sec.
1	Introduction	Automation and Robotics. Robotics in Science Fiction, Progressive Advancement. The Robotics trends and the future prospects.	T1-1
2	Fundamentals of Robot Technology	Robot Anatomy – Links, Joints and Joint Notation scheme, Degrees of Freedom (DOF), Required DOF in a Manipulator	T1-1 R1-2
3		Arm Configuration, Wrist Configuration; The End-effector, Human arm characteristics, Design & Control issues	T1-2 R1-2
4, 5		Precision of Movement, Manipulation & Control, Robotics sensors; Robot specification, Robot programming & work cell control.	R1-2 R2-1,R3-1
6, 7	Analysis & modeling of mechanisms	Mechanisms, Special Mechanism, Four bar planar and Special Mechanism, Mathematical models of simple mechanisms.	-
8, 9, 10	Robot Motion Analysis	Introduction to co-ordinate frames; mappings, Description of objects in space, Transformation of vectors - Rotation & Translation of vectors, Composite transformations. Homogeneous Transform, Fundamental Rotation Matrices; Examples	T1-2, T1-1 R1-4, R2-2 R3-2
11, 12	Kinematics Manipulators	Kinematic Modeling of Manipulator, Direct kinematics model mechanical structure & Notations Description of links & Joints.	T1-3 R1-4

13, 14, 15		Denavit-Hertenberg Notation, kinematic Relationship between links, Manipulator transformation matrix, Examples of direct Kinematics.	T1-3 R1-3, R2-2
16, 17, 18, 19	Inverse Kinematics	Inverse kinematics of manipulator: workspace, solvability of inverse kinematic model. Solution technique, closed form solutions; Examples	T1-4 R1-4, R2-2
20, 21		Singularities of manipulators	T1-5, R3-3
22, 23	Robot end-effectors	Types of end-effectors, methods of holding, Mechanical grippers,; Consideration in gripper selection & design, Gripping Force	R1-5
24, 25, 26	Differential Motion and Statics	Differentia kinematics, linear and angular velocity, Relationship between Transformation matrix and angular velocity, mapping velocity vectors, velocity propagation along links. Manipulator Jacobian, Jacobian Inverse, Jacobian singularities, Static Analysis, Examples.	T1-5 R1-5 R3-5
27, 28, 29, 30, 31	Dynamics of Mechanisms	Introduction, Lagrangian Mechanics, Lagrange – Euler formulation - Velocity of a point on the manipulator, The inertia tensor, The kinetic energy, the potential energy. Equations of Motions, the Lagrangian-Euler (LE) Dynamic model algorithm. Examples.	T1-6 R2-3 R3-6 R1-4
32, 33	The Assembly Tasks	The Interaction of EE with Environment – Assembly, Task Frame Compliances, Active/Passive Compliance, Methods providing Compliance, RCC device.	T1-9,10 R1-15 R3-9
34, 35	Robot Control	Control of movements of mechanical joints, control sequence, n-joints manipulator control system, system performance, control system with damping, control strategy, Architecture of control systems.	T1-8 R2-5, R1-8 R3-7
36, 37	Sensors in Robotics	The meaning of sensing, sensors in Robotics kinds of sensor used in Robotics, Tactile sensors Force-Torque sensors.	T1-8, R2-5 R1-6, R3-7
38, - 42	Robot Programming	Robot Programming issues, optimization position definitions, interpolation language command, data object command, motion commands, gripper command, tool commands, sensors command, other command, Writing programs for different tasks	R1-8, 9 R2-9 R3-9

Home Assignments, Laboratory and Project:

Each student has to workout the given home assignments & work on a project assigned. The project will have seminar(s) and culminate with a written report and presentation of work done.

Evaluation:

Component	Duration	Weightage	Date & Time	Remarks
Mid-Semester Test	90 Min.	30%	7/10 4:00 - 5:30 PM	Open Book
Assignments/Project/Quiz		30%	– Continuous –	
Compre. Exam.	03 Hrs.	40%	7/12 AN	Close & Open

Chamber Consultation: Room No.: 2112.

Notices: All notices will be put up on ME Department Notice Board only.

Instructor-in-charge
ME G511