

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC368	Robotics	3-0-0-3	2016
Prerequisite: EC 307 Power Electronics & Instrumentation, EC 305 Microprocessors & Microcontrollers			
Course objectives: <ul style="list-style-type: none"> To impart knowledge about the engineering aspects of Robots and their applications. 			
Syllabus: Robots: Introduction, anatomy, Robot specifications, Robot characteristics, Areas of application, classification of robots. Robotic arm, Sensors, Encoders, Tachometers, Robotic drive systems and actuators, Specification, principle of operation and areas of application of: DC motor, Stepper motor, Servo motor and brushless DC motor, Microprocessor control of electric motors, speed control using PWM and direction control using H- Bridge, Robotic vision systems, Image processing techniques, kinematics, inverse kinematics, Velocity kinematics, Application of velocity kinematics for all serial manipulators, Digital and Programmable Logic (PLC) controllers. Robot Programming, Industrial applications of Robots, Mobile robots, Micro robots, Recent developments in Robotics.			
Expected outcome: <ol style="list-style-type: none"> The students will have a thorough understanding about Robots and their applications The students will be able to analyse and design robotic structures. 			
Text Books: <ol style="list-style-type: none"> Mikell and Groover, Industrial Robotics – Technology, Programming and Applications, McGraw Hill, 2/e, 2012 Saeed B. Niku Introduction to Robotics. Analysis and control, applications- Wiley student edition, 2010 Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990. 			
References: <ol style="list-style-type: none"> Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006 Fu, K.S,Gonzalez,R.C,Lee, C.S.G.,Robotics, Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987. John. J.Craig, Introduction to Robotics: Mechanics and Control, PHI, 2005. Klafter, R.D., Chmielewski, T.A, Negin, M, Robotic Engineering An Integrated Approach, PHI, 2007 Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Pearson Education, 2000 S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994. 			

Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Introduction – Definition and origin of robotics, Robot Anatomy, Robot specifications, Robot characteristics – accuracy, precision, and repeatability, Areas of application, classification of robots. Robotic arm – Components and structure, Types of joints and workspace, Common kinematic arrangements, Wrists, End effectors.	7	15
II	Sensors: Types and applications of sensors in Robotics, position and displacement sensors, Strain gauge based force-torque sensors, Tachometers. Robotic drive systems and actuators: Hydraulic, Pneumatic and Electric drives. Specification, principle of operation and areas of application of: Stepper motor, Servo motor and brushless DC motor. Microprocessor control of electric motors, speed control using PWM and direction control using H- Bridge	6	15
FIRST INTERNAL EXAM			
III	Robotic vision systems: Imaging, Sensing and Digitization, Image processing techniques, Areas of application in robotics. Introduction to kinematics: Position and orientation of objects, Rotation, Euler angles, Rigid motion representation using Homogenous Transformation matrix.	7	15
IV	Forward kinematics: Link coordinates, Denavit-Hartenberg Representation, Application of DH convention to different serial kinematic arrangements fitted with spherical wrist. Inverse kinematics – General properties of solutions, Kinematic Decoupling, Inverse kinematic solutions for all basic types of three-link robotic arms fitted with a spherical wrist.	9	15
SECOND INTERNAL EXAM			
V	Velocity kinematics – Derivation of the Jacobian, Application of velocity kinematics for serial manipulators, importance of Singularities. Manipulator Dynamics. Introduction to Lagrangian mechanics and Dynamic equation for 2 DOF robots, Introduction to position control and force control of robotic manipulators, Robot actuation and control using PID controllers.	6	20
VI	Robot Programming – Programming methods, Robot language classification, Robot language structure, elements and its functions. Motion, End-effector and Sensor commands in VAL programming language. Simple programs. Industrial applications of Robots in material handling and assembly. Mobile robots, Recent developments in Robotics.	7	20
END SEMESTER EXAM			

Question Paper Pattern (End Semester Examk Pattern)

Max. Marks : 100

Time : 3 Hours

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70 % for theory and 30% for logical/numerical problems, derivation and proof.

