GUJARAT TECHNOLOGICAL UNIVERSITY

MANUFACTURING ENGINEERING(34)

MECHATRONICS

SUBJECT CODE: 2153406

B.E. 5th SEMESTER

Type of course: Theoretical + Practical (Regular)

Prerequisite: To understand the principles, techniques & components of Mechatronics system and robotics.

Rationale: It gives a framework of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs.	% Weightage
1	Introduction: Electronic systems: Conductors, Insulators and Semiconductors – Passive Components used in Electronics. Mechanical systems: Basic concepts – Materials – Heat treatment – Electroplating – Standards.	**4**	**10**
2	Mechatronics, Sensors and Transducers Introduction to Mechatronics systems – Measurement systems – Control systems – Microprocessor based controllers. Sensors and transducers – Performance terminology – Sensors for displacement, position and proximity: Velocity, motion, force, fluid pressure, liquid flow, liquid level, Temperature, light sensors – Selection of sensors	**8**	**20**
3	Actuation Systems Pneumatic and Hydraulic systems – Directional control valve – Rotary actuators – Mechanical actuation systems – Cams – Gear trains – Ratchet and pawl – Belt and Chain drives – Bearings. Electrical actuation systems – Mechanical switches – Solid state switches – Solenoids – Construction and working principle of DC and AC motors – speed control of AC and DC drives, stepper motors – switching circuitries for	**6**	**20**

	stepper motor – AC and DC servo motors		
4	System Models And Controllers Building blocks of mechanical, electrical, fluid and thermal systems – Rotational, transnational, electromechanical, hydraulic and mechanical systems – Continuous and discrete process controllers – Control mode – Two – Step mode - Proportional mode – Derivative mode – Integral mode – PID controllers – Digital controllers – Velocity control – Adaptive control – Digital logic control – Micro processors control.	**8**	**15**
5	Programming Logic Controllers & Design of Mechatronics Programmable logic controllers – Basic structure – Input / Output processing – Programming – Mnemonics – Timers, internal relays and counters – Shift registers – Master and jump controls – Data handling – Analogs Input / Output – Selection of a PLC problem - Stages in designing Mechatronics systems – Traditional and Mechatronics design – Possible design solutions – Case studies of Mechatronics systems – Pick and place robot – Automatic car park systems – Engine management systems	**8**	**15**
6	Robot Kinematics & Dynamics Introduction – Matrix representation - Homogenous transformation, forward and reverse – Kinematic equations, Denvit – Hartenbers representations – Inverse kinematics relations. Fundamental problems with DH representations, differential motion and velocity of frames – Jacobian, Differential charges between frames – Lagrangeon mechanics - Dynamic equations of single, double and multiple DOF robots – Static force analysis of robots, Trajectory planning – Joint space, Cartesian space description – 3^{rd} and 5^{th} order – Polynomial trajectory planning.	**10**	**20**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Bolton W., "Mechatronics", 2nd Edition, Pearson Education, 1999.
2. Saeed B Niku "Introduction to Robotics, Analysis, System, Applications" Pearson Publications 2002
3. Michael B. Histand and Alciatore, D.G., "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 2000.
4. Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall,1993.
5. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002.
6. Kamm, L. J., "Understanding Electro – Mechanical Engineering", An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.

7. Nitaigour Premchand Mahadik, “Mechatronics”, Tata McGraw-Hill publishing Company Ltd, 2003.

Course Outcome:

After learning the course the students should be able to:

List of Experiments:

1. Design a simple pneumatic direct control circuit to open and close the Gate of a factory. By operating a push button valve, gate should open or close
2. Design of pneumatic circuit using a double acting cylinder and 5/2 Air Spring Valve to open the main gate of a factory which can be controlled by a security personnel from the security room.
3. Design of Hydraulic circuit using a double acting cylinder and 4/2 hand operated valve to raise or lower the pallet truck.
4. To study about the programming of the PLC using Ladder diagram to switch ON the 230V AC Lamp using start button and switch OFF the Lamp using stop button (Latching circuit).
5. Using PLC, Write and simulate a program to move the forward stroke of a pneumatic double acting cylinder in 15seconds and to return after 10seconds.
6. Real Time Temperature controller
7. Servo motor using closed and open loops
8. Multipurpose station current to pressure transmitter and flow transmitter.
9. Study and applications of 8051 Micro controller
10. Study of Pick and Place Robot.

Evaluation of Open ended / design based small project

1. Operating the stepper motor at different speed and different directions.
2. PLC applications for various assignments
3. Programming codes for robots for different types of work required.

Major Equipment:

1. PLC
2. Microcontroller
3. Temperature Controller
4. Pneumatic and Hydraulic actuators and cylinders

List of Open Source Software/learning website:

http://nptel.ac.in/courses/112106138

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the

group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.