INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**INDUSTRIAL AUTOMATION AND CONTROL**				
Course Code	**AEE511**				
Programme	**B.Tech**				
Semester	**V**	**EEE**			
Course Type	**Elective**				
Regulation	**IARE - R16**				
Course Structure		**Theory**			**Practical**	
		Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
		3	0	3	3	2
Chief Coordinator	**Dr. V Chandra Jagan Mohan, Associate Professor**				
Course Faculty	**Dr. V Chandra Jagan Mohan, Associate Professor** **Dr. M Pala Prasad Reddy, Assistant Professor**				

I. COURSE OVERVIEW:

This course provides an overall exposure to industrial automation and control, which is playing a key role in Industries. Industries rely heavily on automation for economic viability and mass production. This course discusses architecture of automation systems, various measuring instruments used in industrial automation. It also gives an emphasis on PID and predictive controllers along with programmable logic controller (PLC) hardware and programming. This course also discusses hydraulic, pneumatic and electric actuators and computer numerical control (CNC) Machines used to implement control actions in industrial automation.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEE004	III	DC Machines and Transformers	4
UG	AEE007	IV	AC Machines	4
UG	AEE008	IV	Electrical Measurements and Instrumentation	4
UG	AEE009	IV	Control Systems	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Industrial Automation and Control	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weight age in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical and application skills of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks

shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

	Program Outcomes (POs)	Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Discussion and Seminars
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	Seminars
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Laboratory Practice
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Laboratory Practice

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

	Program Specific Outcomes (PSOs)	Strength	Proficiency assessed by
PSO1	**Problem Solving**: Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	-	-
PSO2	**Professional Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	2	Seminars
PSO3	**Modern Tools in Electrical Engineering:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test, maintain power system and applications.	2	Videos, Open ended experiments

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Learn the fundamental concepts about introduction to industrial automation and control and devices.
II	Study the performance of each system in detail along with practical case studies.
III	Develop various types of industrial automation and control and devices.
IV	Understand the process control of PLC automation.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO1	Describe working of various blocks of basic industrial automation system.	CLO 1	Describe the various elements of an Industrial Automation Systems and how they are organized hierarchically in levels.
		CLO 2	Define the different terms used for characterizing the performance of an instrument/ measurement system
		CLO 3	Report the different methods for measurement of temperature, pressure, force, displacement and speed.
CO2	Analyse various control aspects for the automation application.	CLO 4	Describe the signal conditioning circuits and indentify different types of errors.
		CLO 5	Discuss the input-output relationship of a P-I-D controller.
		CLO 6	Explain the use of feed forward and ratio control schemes.
		CLO 7	Explain the predictive control schemes and also compensation scheme for control of a process with inverse response.
CO3	Construct a program using PLC to problems pertaining to automation industries.	CLO 8	Define Sequence and Logic Control and report the major functions performed by a PLC.
		CLO 9	Describe the hardware structure of a PLC Program and the execution of a PLC Program.
		CLO 10	Describe motivations for formal modeling in the design of sequence control programs for an industrial control problem.
		CLO 11	Describe the physical organization of hardware in the PLC.
CO4	Describe the principal and operation of CNC machines and actuators.	CLO 12	Define Numerical Control and describe its advantages and disadvantages.
		CLO 13	Name the types of control valves and sketch their ideal flow characteristics.
		CLO 14	Describe the principles of operation of hydraulic systems and understand its advantages.
		CLO 15	Describe pressure switches, as well as pressure and flow gauges used in hydraulic systems.
CO5	Distinguish various industrial drives for the industrial automation.	CLO 16	Demonstrate energy saving with variable speed drive method of flow control compared to throttling.
		CLO 17	Explain with schematic diagrams, open loop and closed loop control schemes used for step motors.
		CLO 18	Describe the operational features of dc motor drives, Induction motor drives, BLDC motor drives for Electrical actuators.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE511.01	CLO 1	Describe the various elements of an Industrial Automation Systems and how they are organized hierarchically in levels.	PO1	3
AEE511.02	CLO 2	Define the different terms used for characterizing the performance of an instrument/ measurement system.	PO1, PO2	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE511.03	CLO 3	Report the different methods for measurement of temperature, pressure, force, displacement and speed.	PO1, PO2	3
AEE511.04	CLO 4	Describe the signal conditioning circuits and indentify different types of errors.	PO3	3
AEE511.05	CLO 5	Discuss the input-output relationship of a P-I-D controller'	PO1, PO2	3
AEE511.06	CLO 6	Explain the use of feed forward and ratio control schemes.	PO2, PO5	2
AEE511.07	CLO 7	Explain the predictive control schemes and also compensation scheme for control of a process with inverse response.	PO1, PO5	2
AEE511.08	CLO 8	Define Sequence and Logic Control and report the major functions performed by a PLC.	PO1, PO5	2
AEE511.09	CLO 9	Describe the hardware structure of a PLC Program and the execution of a PLC Program.	PO2,PO5	3
AEE511.10	CLO 10	Describe motivations for formal modelling in the design of sequence control programs for an industrial control problem.	PO2, PO5	2
AEE511.11	CLO 11	Describe the physical organization of hardware in the PLC.	PO1, PO2	3
AEE511.12	CLO 12	Define Numerical Control and describe its advantages and disadvantages.	PO2, PO3	2
AEE511.13	CLO 13	Name the types of control valves and sketch their ideal flow characteristics.	PO1, PO2	2
AEE511.14	CLO 14	Describe the principles of operation of hydraulic systems and understand its advantages.	PO1, PO2	3
AEE511.15	CLO 15	Describe pressure switches, as well as pressure and flow gauges used in hydraulic systems.	PO1, PO2	2
AEE511.16	CLO 16	Demonstrate energy saving with variable speed drive method of flow control compared to throttling.	PO2, PO3	2
AEE511.17	CLO 17	Explain with schematic diagrams, open loop and closed loop control schemes used for step motors.	PO2, PO3	2
AEE511.18	CLO 18	Describe the operational features of dc motor drives, Induction motor drives, BLDC motor drives for Electrical actuators.	PO1, PO2	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)					
	PO 1	PO 2	PO 3	PO 5	PSO2	PSO3
CO 1	2	2		3	2	2
CO 2			2	3	2	2

CO 3			2	3	2	
CO 4			2	3	2	2
CO 5			2	3	2	

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

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3														
CLO 2	3	3													
CLO 3	3	3												2	
CLO 4			3											2	
CLO 5	3	2												2	
CLO 6		2			2									2	
CLO 7		2			2									2	
CLO 8	2				2										2
CLO 9		3			3										2
CLO 10		2			2										
CLO 11	2	2													2
CLO 12		2	2												
CLO 13	2	2													
CLO 14	3	2													
CLO 15	2	2													
CLO 16		2	2											2	
CLO 17		2	2											2	
CLO 18	2	2													

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3, PO5, PSO2,PSO3	SEE Exams	PO1, PO2, PO3, PO5, PSO2,PSO3	Assignments	PO2, PO3, PO5	Seminars	PO2, PO5
Laboratory Practices	PO3, PSO3	Student Viva	PO2, PO3, PSO3	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	INTRODUCTION TO INDUSTRIAL AUTOMATION AND CONTROL
Introduction to Industrial Automation and Control: Introduction to industrial automation and control architecture of industrial automation system, measurement systems specifications, temperature measurement, pressure and force measurement, displacement and speed measurement, signal conditioning circuits, errors and calibration.	

UNIT-II	PROCESS CONTROL
Process control: Introduction to process control, PID control, controller tuning, implementation of PID controllers, special control structures, feed forward and ratio control special control structures: predictive control, control of systems with inverse response.	

UNIT-III	PROGRAMMABLE LOGIC CONTROL SYSTEMS
Programmable logic control systems: introduction to sequence or logic control and programmable logic controllers, the software environment and programming of PLCs, formal modeling of sequence control specifications. Programming , programming of PLCs: sequential function charts, the PLC hardware environment	

UNIT-IV	CNC MACHINES AND ACTUATORS
CNC machines and actuators: Introduction to computer numerically controlled machines, control valves, hydraulic actuation systems, principle and components, directional control valves, switches and gauges, industrial hydraulic circuits.	

UNIT-V	ELECTRICAL MACHINE DRIVES
Electrical machine drives: Energy savings with variable speed drives, step motors: principles, construction and drives, electrical actuators, DC motor drives, electrical actuators: induction motor drives, electrical actuators, BLDC motor drives.	

Text Books:
1. Madhu Chanda Mitra, Samarjit Sen Gupta, "Programmable Logic Controllers and Industrial Automation: An Introduction", Penram International Publishing (India) Pvt. Ltd., 1 st Edition, 2008.
2. K Krishnaswamy, S Vijayachitra, "Industrial Instrumentation", New Age Publications, 1 st Edition, 2010.
3. Rajesh Mehra, Vikrant Vij, "PLCs & SCADA: Theory and Practice", Laxmi publications, 2nd Edition, 2016.

Reference Books:

1. AK Gupta, S K Arora, "Industrial Automation and Robotics", Laxmi Publications, 2nd Edition, 2013.
2. Jon Stenerson, "Industrial Automation and Process Control", Prentice Hall, 1st Edition, 2002.

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	CLOs	Reference
1	Understand the benefits of industrial automation and control.	CLO 1	T1: 1.1 – 1.5

Lecture No	Topics to be covered	CLOs	Reference
2	Know the architecture of industrial automation.	CLO 1	T1: 1.1 – 1.5
3	Illustrate the different terminology used in measuring systems	CLO 2	T3: 1.1.1 – 1.1.2
4	Explain the different methods used for measuring the temperature.	CLO 3	T3: 1.3.1
5	Describe the operation of force and pressure measuring devices.	CLO 3	T3: 1.3.3
6	Discuss the operation of displacement measuring circuits.	CLO 3	T3: 1.3.2 - 1.3.4
7	Discuss the operation of speed measuring devices.	CLO 3	T3: 1.3.8
8	Analyse the different signal conditioning circuits used for measuring circuits.	CLO 4	T3: 2.1 – 2.4
9	Analyse the different types of errors in the instruments during the measurement.	CLO 4	T3: 5.2
10	Illustrate the process control system and issues related to process control	CLO 5	T3: 5.7
11	Describe the PID controllers used in the control circuits and list the advantages of each type of PID controllers	CLO 5	T3: 5.7
12	Understand the different methods used for tuning of PID controllers	CLO 5	T3: 5.7
13	Implement a electronic and digital PID controller for process control and differentiate them with each other	CLO 5	T3: 5.7
14	Justify the use of feed forward controller in addition to conventional feedback controller.	CLO 6	T1: 9.1 -9.4
15	Write the typical applications of ratio control and give two possible arrangements for achieving ratio control	CLO 6	T1: 9.1 -9.4
16	Explain with an example the difficulty in controlling a process with dead time.	CLO 7	T1: 9.1 -9.4
17	Draw and explain the function of Smith Predictor Compensation Scheme.	CLO 7	T1: 9.1 -9.4
18	Write down the transfer function of process with inverse response and sketch its step response.	CLO 7	T1: 9.1 -9.4
19	State three major differences between Logic Control and Analog Control	CLO 8	T1: 9.1 -9.4
20	Define a Programmable Logic Controller and name its major structural components	CLO 8	T1: 6.2 – 6.3
21	Name the major functions performed by a PLC along with the structure and execution of a PLC Program	CLO 9	T1: 3.1 – 3.8
22	Design RLL Diagrams for simple industrial logic control problems	CLO 9	T1: 3.1 – 3.8
23	Describe motivations for formal modelling in the design of sequence control programs for an industrial control problem.	CLO 10	T1: 7.1 – 7.5
24	Describe the major steps in the design of a sequence control program for an industrial control problem.	CLO 10	T1: 7.1 – 7.5
25	Develop a Finite State machine model for simple industrial control problems	CLO 10	T1: 7.1 – 7.5
26	Describe the major features of the IEC 1131-3 standard for PLC programming	CLO 10	T1: 7.2 -7.4
27	Describe the major syntax conventions of the SFC programming language	CLO 10	T1: 7.2 -7.4
28	Develop SFC programs for simple sequence control problems	CLO 10	T1: 7.2 -7.4
29	Describe the physical organization of hardware in the PLC	CLO 11	T1: 6.1 – 6.10
30	Describe typical Function modules used in PLC systems	CLO 11	T1: 6.1 – 6.10
31	Name and describe the major components and classifications of CNC Machines	CLO 12	T1: 5.7

Lecture No	Topics to be covered	CLOs	Reference
32	Explain the basic principle of operation of a pneumatically actuated control valve	CLO 13	T1: 5.7
33	Name types of control valves and sketch their ideal flow characteristics.	CLO 13	T1: 5.7
34	Describe the principles of operation of hydraulic systems and understand its advantages	CLO 14	T1: 2.2
35	Describe the constructional and functional aspects of hydraulic pumps and motors	CLO 14	T1: 2.3
36	Describe the major types of direction control valves, their construction, operation and symbol	CLO 14	T1: 5.7
37	Describe pressure switches, as well as pressure and flow gauges used in hydraulic systems	CLO 15	T2: 2.1 - 2.4
38	Interpret hydraulic system symbols and circuit diagrams	CLO 15	T2: 2.1-2.4
39	Demonstrate energy saving with variable speed drive method of flow control compared to throttling	CLO 16	T2: 3.2
40	Identify the major constructional difference between a permanent magnet and variable reluctance type motor.	CLO 16	T2: 3.2.3
41	Develop the switching sequence for a given step motor according to given requirements.	CLO 17	T2: 3.2.1
42	Explain with schematic diagrams, open loop and closed loop control schemes used for step motors.	CLO 17	T2: 3.2.1
43	Derive the dynamic speed response characteristics relating armature voltage, load torque and speed.	CLO 18	T2: 3.2.2
44	Describe the realization of a variable voltage controlled source using switch mode power converters.	CLO 18	T2: 3.2.3
45	Describe the structure and principle of operation of PM BLDC motor.	CLO 18	T2: 3.2.2

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Introduction to Human Machine Interface (HMI) and its interfacing with PLC	Seminars, Open ended experiments	PSO 2, PO5	PSO 3
2	Controlling of Variable frequency Drive (VFD) through PLC	Seminars, Open ended experiments	PSO 2, PO5	PSO 3

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