Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title:	**MECHATRONICS**	Course Code	**: 15EE63A**
Semester	**: VI**	Course Group	**: Core**
Teaching Scheme (L:T:P) : **4:0:0** (in Hours)		Credits	**: 4 Credits**
Type of course	**:Lecture +Assignments**	Total Contact Hours : **52**	
CIE	**: 25 Marks**	SEE	**: 100 Marks**
Programme: Diploma in Electrical and Electronics Engg.			

Pre-requisites	**: K**nowledge on basics of electrical engineering, analog and digital electronics.
Course Objectives	**:** To understand the various Transducers, Sensors, Actuation system. Also, to introduce the concept of Signal conditioning, data acquisition and data presentation along with PLC and MEMS used in Mechatronics system.

COURSE TOPICS:

Unit No	Unit Name	Hours
1	Introduction to Mechatronics System	05
2	Transducers and Sensors	13
3	Signal Conditioning ,Data Acquisition and data presentation	10
4	Actuation system	08
5	Applications of Mechatronics system	06
6	PLC and MEMS	10
	Total	**52**

Course Outcomes:

On successful completion of the course, the student will be able to:

1. Remember the basics of Mechatronics measurement system

2. Understand the working of various Transducers and Sensors

3. Perform data acquisition, signal conditioning and data representation

4. Analyse the working of various actuation system

5. Understand the applications of Mechatronics system

6. Illustrate applications of PLC and MEMS

Composition of Educational Components

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's Taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)	Total Marks (Out of 145)
1	Remembering	15	15
2	Understanding	70	70
3	Application/ Analysis	60	60
Total		**100**	**145**

Course Outcome linkage to Cognitive Level

Cognitive Level Legend: R- Remember, U- Understand, A- Application

		CL	Linked PO	Teaching Hrs
CO1	Remember the basics of Mechatronics measurement system	*R*	2,10	05
CO2	Understand the working of various Transducers and Sensors	*U/A*	2,4,5, 10	13
CO3	Perform data acquisition, signal conditioning and data representation	*R/U*	2, 4,5,10	10
CO4	Analyse the working of various actuation system	*U/A*	4,5,10	08
C05	Understand the applications of Mechatronics system	*U/A*	4,5,8 10	06
C06	Illustrate applications of PLC and MEMS	*R/U/A*	4,5, 810	10
			Total	**52**

Course Content and Blue Print of Marks for SEE:

Unit	Unit Name	R/U/A	Hour	Max. Marks per Unit	5 Marks Qns. Part A	10 Marks Qns. Part B	Questions to be set for (5marks) PART - A			Questions to be set for (10marks) PART - B			Marks Weightage (%)
							R	U	A	R	U	A	
1	Introduction to Mechatronics System	*R*	5	10	1	0.5		1				0.5	7
2	Transducers and Sensors	*U/A*	13	35	1	3		1			1	2	24
3	Signal Conditioning , Data Acquisition and data presentation	*R/U*	10	30	2	2	1	1		1	1		21
4	Actuation system	*U/A*	8	20	1	1.5		1				1.5	14
5	Applications of Mechatronics system	*U/A*	6	20	2	1	1	1			1		14
6	PLC and MEMS	*R/U/A*	10	30	2	2	1	1		1	1		21
	TOTAL		52	145	9	10	**9 (45 Marks)**			**10 (100 Marks)**			

Course-PO Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
MECHATRONICS		3		3	3			2		3

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course Content:

Unit –I
Introduction to Mechatronics System (5 Hrs)

Definition and scope, Evolution levels, advantages and disadvantages of mechatronics, component of mechatronics system with example. Introduction to measurement system and its applications. Control system- open and closed loop system (Digital closed loop control system), adaptive control system.

Unit –II

Transducers and Sensors (13 Hrs)

Introduction, definition and classification of Transducers. Measurement versus Transduction methods, selection and specifications of transducer. Electromechanical –Resistance transducers (linear and angular motion potentiometer), variable inductor transducer (LVDT), RVDT, synchros, load cells, Capacitive transducer (capacitive tachometer). Piezoelectric transducers-materials, properties and working of piezoelectric device, digital transducers. Advantages and disadvantages of piezoelectric transducers. Piezoelectric accelerometer, Hall effect transducers. Photoelectric transducer – photoelectric tachometer. Strain gauges-types, requirements, wheat stone bridge (null mode).Sensors- definition, types and selection of sensors. Proximity sensor (eddy current proximity sensor), light sensor-digital optical encoder, temperature sensor- bimetallic strips, Resistance Temperature detectors (RTDs), thermistor and thermocouples.

Unit –III

Signal Conditioning, Data Acquisition and data presentation (10 Hrs)

Measurement system components, Necessity of signal conditioning. process adopted in signal conditioning. Function of signal conditioning equipments. AC and DC signal conditioning system. Data acquisition-introduction, DAQ system. Analog to digital conversion (ADC)-digital signal, ADC process, components, A/D converter- successive approximation type. Digital to analog conversion- R -2R ladder DAC. Data presentation-General aspects, electrical indicating instruments, electrical analog and digital instruments, Recorder, printer and display system.

Unit –IV

Actuation system (8 Hrs)

Introduction –types, Mechanical actuators – Kinematic link, Kinematic chain –types, gear drive –introduction, types Gear train –definition, types. Belt and belt drive. Chain and chain drives, bearings. Electrical actuators-types, switching devices –mechanical switches, solid state switches, drives. Solenoid Relays. Hydraulic actuators - components of hydraulic system, hydraulic valves - spool valve, poppet valve. Linear actuators –single rod single acting cylinder, single rod double acting cylinder. Pneumatic actuators- comparison of Hydraulic and Pneumatic actuators, components of pneumatic system, pneumatic valves – types fluid control system, current to pressure converter.

Unit –V
Applications of Mechatronics System (6 Hrs)

Introduction to robotics .microprocessor based robotic system, Description of some electrical, electronics, mechanical systems - automatic camera, automatic washing machine, car engine management, pick and place robot.

Unit –VI
PLC and MEMS (10 Hrs)

Introduction, features, selection of PLC, architecture of PLC, operation cycle of PLC, advantages and disadvantages of PLC. Programming, ladder diagram-basic logic gates, timers, internal relay, counters. MEMS-advantages, applications, description of MEMS, general block diagram, manufacturing of MEMS. MEMS accelerometer, humidity sensor, smart sensors.

Reference Books:

1.A Text Book of Mechatronics, by R.K. Rajput, SChand and Company Ltd, New Delhi.
2. Mechatronics (Third Edition), by W. Bolton ,Pearson Education , New Delhi.
3. Mechatronics – Principles, Concepts and Applications, byNitaigourPremchandMahalik, Tata McGraw Hill Publishing Company Ltd, New Delhi.

e-Resources:

1. www.allaboutmems.com
2. www.mems.org

Course Delivery:

The Course will be delivered through lectures, classroom interaction, animations, group discussion, exercises and student activities, assignments.

Course Assessment and Evaluation:

		What	To Whom	Frequency	Max Marks	Evidence Collected	Course Outcomes
Direct Assessment	CIE (Continuous Internal Evaluation)	I A Tests	Students	Three IA tests for Theory: (Average marks of Three Tests to be computed).	20	Blue Books	1 to 6
		Student Activity		Student Activity	05	Report of 2 pages	1 to 6
				TOTAL	**25**		
	SEE (Semester End Examination)	End Exam	Students	End Of the Course	100	Answer Scripts at BTE	1 to 6
Indirect Assessment		Student Feedback on course	Students	Middle Of The Course	Feed Back Forms		1 to 6
		End Of Course Survey		End Of The Course	Questionnaires		1 to 6

*CIE – Continuous Internal Evaluation   *SEE – Semester End Examination

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Note to IA verifier: *The following documents to be verified by CIE verifier at the end of semester*

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks evaluated through appropriate rubrics.
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods.

Course Contents with Lecture Schedule:

Lesson No./ Session No.	Contents	Duration
Unit I	**Introduction to Mechatronics System**	**05 Hours**
1.	Definition and scope, evolution levels, advantages and disadvantages of mechatronics, component of mechatronics system with example	01 Hour
2.	Introduction to measurement system and list the applications	01 Hour
3.	Control system- open and closed loop system (Digital closed loop control system)	01 Hour
4.	Descriptive and block diagram of adaptive control system	01 Hour
5.	Gain scheduled, self tuning, model reference adaptive control system	01 Hour
Unit II	**Transducers and Sensors**	**13 Hr**
6.	Introduction, definition and classification of Transducers.	01 Hour
7.	Measurement versus Transduction methods, selection and specifications of transducer	01 Hour
8.	Electromechanical – Resistance transducers (linear and angular motion potentiometer),	01Hour
9.	Linear variable differential transformer (LVDT), Rotary variable differential transformer (RVDT)	01 Hour
10.	Synchros – practical setup, load cells – construction and working of Hydraulic and strain gauge load cells	01 Hour
11.	Capacitive transducer (capacitive tachometer) and Introduction to Piezoelectric transducers	01 Hour
12.	Piezoelectric transducers - materials, properties and working of piezoelectric device, digital transducers.	01Hour
13.	Advantage and disadvantages of piezoelectric transducers. Piezoelectric accelerometer,	01 Hour
14.	Hall effect transducers. Photoelectric transducer – photoelectric tachometer.	01 Hour
15.	Strain gauges - types, requirements, wheat stone bridge (null mode).	01 Hour
16.	**Sensors**- definition, types and selection of sensors. Proximity sensor (eddy current proximity sensor),	01 Hour
17.	Light sensor - digital optical encoder,	01 Hour
18.	Temperature sensor- bimetallic strips, Resistance Temperature detectors (RTDs), thermistor and thermocouples.	01 Hour
Unit III	**Signal Conditioning, Data Acquisition and data presentation**	**10 Hr**

19.	Measurement system components, Necessity of signal conditioning, process adopted in signal conditioning	01 Hour
20.	Function of signal conditioning equipments. AC and DC signal conditioning system.	01 Hour
21.	Data acquisition -introduction, DAQ system – Data logger, computer with plug in boards	01 Hour
22.	Analog to digital conversion (ADC) - digital signal, ADC process, components, A/D converter- successive approximation type	01 Hour
23.	Digital to analog conversion (DAC) - R -2R ladder DAC	01 Hour
24.	Data presentation / Display - General aspects, electrical indicating instruments	01 Hour
25.	Analog and digital instruments	01 Hour
26.	Recorders – types, X-Y recorder, UV recorder, magnetic tape	01 Hour
27.	Printers –dot matrix, Laser and ink jet type	01 Hour
28.	Display system – Light indicators, LED display,5 by 7 dot matrix LED display	01 Hour
Unit IV	**Actuation system**	**08 Hours**
29.	Introduction –types, Mechanical actuators – Kinematic link, Kinematic chain –types	01 Hour
30.	Gear drive –introduction, types, Gear train –definition, types. Belt and belt drive. Chain and chain drives, bearings.	01 Hour
31.	Electrical actuators-types, switching devices –mechanical switches ,Solid state switches ,Solenoid Relays.	01 Hour
32.	Drives – Electric motors- AC and DC servo motors, characteristics, types and applications.	01 Hour
33.	Hydraulic actuators - components of hydraulic system, hydraulic valves - spool valve, poppet valve.	01 Hour
34.	Linear actuators –single rod single acting cylinder, single rod double acting cylinder.	01 Hour
35.	Pneumatic actuators- comparison of Hydraulic and Pneumatic actuators, components of pneumatic system,	01 Hour
36.	Pneumatic valves – types fluid control system, current to pressure converter	01 Hour
Unit V	**Applications of Mechatronics System**	**06 Hr**
37.	Introduction to robotics – definition, functions, advantage and disadvantages, classification .	01 Hour
38.	robotic system, microprocessor based robotic system	01 Hour
39.	Description of some electrical, electronics, mechanical systems (block diagram approach)- Automatic camera	01 Hour

40.	Automatic washing machine	01 Hour
41.	Car engine management,	01 Hour
42.	Pick and place robot and Temperature measurement system	01 Hour
Unit VI	**PLC and MEMS**	**09 Hr**
43.	Introduction, features, selection of PLC	01 Hour
44.	Architecture of PLC, operation cycle of PLC, advantages and disadvantages of PLC.	01 Hour
45.	Programming, ladder diagram - basic logic gates	01 Hour
46.	Programming using Timers, internal relay and counters	01 Hour
47.	Programming, ladder diagram - basic logic gates	01 Hour
48.	Programming using Timers, internal relay and counters	01 Hour
49.	MEMS –Introduction, advantages, applications, description of MEMS	01 Hour
50.	General block diagram, manufacturing of MEMS.	01 Hour
51.	Construction and working MEMS accelerometer	01 Hour
52.	Construction and working of Humidity sensor, smart sensors	01 Hour
	TOTAL:	**52 HOURS**

Student Activity (any one to be submitted with 3 pages self HAND WRITTEN report):

1. Study and identify the components of a open and closed loop control system with examples
2. List different kinds of transducers and sensors apart from the curriculum. Explain any two in detail.
3. Develop one hardware for simple data acquisition system
4. List different kinds of Mechanical Actuation system apart from the curriculum. Explain any two in detail.
5. Perform the market survey and write brief comparative report on any one mechatronics application
6. List the various types of PLC's and briefly write the description on any two branded PLC
7. List the various types of MEMS sensors and briefly write the description on any two branded MEMS sensors

MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY (Course Coordinator)

Dimen sion	Scale					Students score (Group of five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	3				
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2				
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	5				
4	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	4				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks **One activity on any one CO (course outcome) may be given to a group of FIVE students** **Grand Average/Total**						14/4 =3.5 ≈4				

Dimension	Scale					Students score (Five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1.Organisation	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed	3				
2. Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles	2				
3.Conclusion	Poor	Less Effective	Partially effective	Summarises but not exact.	Most Effective	5				
4.Convensions	Frequent Error	More Error	Some Error	Occasional Error	No Error	4				
					Total marks	14/4=3.5 ≈4				

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th week of sem 10-11 Am	VI SEM		20
	Year:		

Name of Course coordinator :
Units:__ CO's:____

Questio n no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal Choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year		Course/Course Code		Max Marks
1st Test/ 6th week, 9 Feb 16, 10-11 AM	VI SEM, E & E Engg		**MECHATRONICS**		20
	Year: 2016-17		Course code:15EE63A		

Name of Course coordinator :
Units Covered :1 and 2
Course Outcomes : 1 and 2
Instruction :(1). Answer all questions   (2). Each question carries five marks

Question No.	Question	CL	CO	PO
1	Define Mechatronics with examples.	R	1	2, 10
2	Describe closed loop control system with example OR Describe self tuning control system with block diagram	R R	1	2, 10
3	Relate any 5 measurement versus transduction methods OR State the factor to considered for selection of sensors	U U	2	2, 10
4	Explain the working of digital optical encoder with a diagram	A	2	2, 10
	CL: Cognitive Level, R-Remember, U-Understand, A-Application, PO: Program Outcomes			

MODEL QUESTION PAPER BANK:

Course Title: **MECHTRONICS**	Course Code: 15EE63A

CO1- Remember the basics of Mechatronics measurement system
Unit 1 -Introduction to Mechatronics System

Cognitive Level: REMEMBER

1) Define Mechatronics with examples.
2) List the advantage and disadvantages of Mechatronics.
3) State and explain the evolution level of Mechatronics
4) List the components of mechatronics system
5) Label the components of mechatronics system in a block diagram
6) Enumerate and explain briefly the elements of measuring system
7) Describe open loop control system with example
8) Describe closed loop control system with example
9) Describe adaptive control system with block diagram for velocity feedback
10) Describe adaptive control system with descriptive diagram for velocity feedback
11) Describe gain schedule control system with block diagram
12) Describe self tuning control system with block diagram
13) Describe model reference adaptive control system with block diagram

CO2- Understand the working of various Transducers and Sensors
Unit 2 -Transducers andSensors

Cognitive Level: UNDERSTAND

14) Define and classify transducer.
15) Enumerate any 5 measurement versus transduction methods.
16) State the advantage and disadvantages of piezoelectric transducers
17) List different types of Strain gauges
18) Define and classify sensors
19) State the factor to considered for selection of sensors
20) List different types of Proximity sensor
21) List different types of Light sensor
22) List different types of   temperature sensor

Cognitive Level: APPLICATION/ANALYSIS

23) Explain different factor to be considered for selection of transducer

24) Explain linear and angular motion potentiometer resistance transducer
25) Explain Linear variable differential transformer (LVDT)with a diagram.
26) Explain Rotary variable differential transformer (RVDT)with a diagram.
27) Describe practical setup of Synchros with a neat diagram .
28) Explain construction and working of Hydraulic and strain gauge load cells
29) Explain capacitive pick up tachometer with diagram.
30) Explain the working of piezoelectric device.
31) Explain the working of piezoelectric accelerometer with a diagram.
32) Explain Hall effect transducer
33) Explain photoelectric tachometer with diagram.
34) Explain the working of wheat stone bridge as strain -gauge in null mode
35) Explain the working of eddy current proximity sensor with diagram.
36) Explain the working of digital optical encoder with a diagram
37) Briefly explain bimetallic strips with diagram
38) Write a short note on RTD(Resistance Temperature detectors)
39) Explain thermistors
40) Explain thermocouples.

CO3- Perform data acquisition, signal conditioning and data representation
Unit 3 -Signal Conditioning, Data Acquisition And Data Presentation

Cognitive Level: UNDERSTAND

41) Identify the components of Measurement system
42) List different function of signal conditioning equipments
43) Describe data acquisition system.
44) Differentiate ADC and DAC
45) Classify Data presentation methods.
46) List different types of recorders
47) List different types of printers
48) List different types of display systems.

Cognitive Level: APPLICATION/ANALYSIS

49) Write the block diagram of Measurement system components and explain.
50) Discuss the necessity of signal conditioning
51) Explain the process adopted in signal conditioning
52) Explain the function of signal conditioning equipments
53) Explain AC signal conditioning system with a diagram
54) Explain DC signal conditioning system with a diagram
55) Explain the DAQ system with a diagram
56) Explain successive approximation type ADC with a neat diagram.
57) Write R-2R ladder DAC diagram and explain.
58) Explain briefly different types of data presentation methods.

CO4- Analyse the working of various actuation system
Unit 4 - Actuation system

Cognitive Level: UNDERSTAND

59) List the different types of Mechanical actuators
60) Write a short note on Kinematic link and Kinematic chain
61) Define gear drive and List the different types of Gear drive
62) Differentiate belt drive and chain drives
63) List the different types of bearings.
64) List the different types of electrical actuators
65) List the different types of servomotors
66) applications AC and DC servo motors, characteristics, types and applications
67) List the different types of hydraulic actuators
68) Define linear actuators and List the different types of linear actuators
69) Compare of Hydraulic and Pneumatic actuators
70) List the different types of Pneumatic valves

Cognitive Level: APPLICATION

71) Explain the advantage of solid state switch over mechanical switch
72) Sketch and explain the working of solenoid relay.
73) Explain the components of hydraulic system with a neat diagram.
74) Describe the working of spool valve with a sketch.
75) Describe the working of poppet valve with a sketch.
76) Explain the working of single rod single acting cylinder
77) Explain the working of single rod double acting cylinder
78) Explain components of pneumatic system with a diagram.
79) Explain the fluid control system with a diagram
80) Explain current to pressure converter with a diagram.

CO5- Understand the applications of Mechatronics system
Unit 5 - Applications of Mechatronics System

Cognitive Level: UNDERSTAND

81) Define robotic system.
82) List the advantages and disadvantages of robotic
Cognitive Level: APPLICATION
83) Write classification of robotic
84) Explain the functions of robotics
85) Explain the robotic system
86) Explain microprocessor based robotic system with a block diagram

87) Explain the working of automatic camera with a block diagram
88) Explain the working of automatic washing machine with a block diagram
89) Explain the working of car engine management with a block diagram
90) Explain the working of pick and place robot with a block diagram
91) Explain the working of temperature measurement system with a block diagram

CO6- Illustrate applications of PLC and MEMS
Unit 6 - PLC and MEMS

Cognitive Level: REMEMBER
92) Define PLC and List the applications.
93) List the features of PLC.
94) List the advantages and disadvantages of PLC
95) List different programming methods of PLC and explain briefly.
96) Define MEMS.
97) List the applications of MEMS.
98) List the advantages of MEMS.

Cognitive Level: UNDERSTAND
99) Explain the Architecture of PLC with a block diagram.
100) Explain different operation cycles of PLC
101) Explain the counter in PLC.
102) Explain the timer in PLC.
103) Explain the internal relay in PLC.
104) Write the general block diagram of MEMS.
105) Explain the different techniques employed for manufacturing of MEMS

Cognitive Level: APPLICATION
106) Explain how to select PLC for particular application.
107) Analyse ladder diagram for basic logic gates.
108) Explain the assembly language programming for basic gates in PLC.
109) Differentiate on delay and off delay timer in PLC
110) Differentiate up counter and down counter in PLC
111) Explain construction and working MEMS accelerometer with a diagram.
112) Explain construction and working of Humidity sensor with a diagram
113) Explain construction and working of smart sensors with a block diagram

Model Question Paper:
Code: 15EE63A

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VI Semester Examination

Diploma in Electrical and Electronics Engg.

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Time: 3 Hours
Max Marks: 100

Note: i) Answer any SIX questions from PART - A. Each question caries 5 marks.

ii) Answer any SEVEN Questions from PART - B. Each question caries 10 marks.

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PART – A

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1) List the advantage and disadvantages of Mechatronics

2) State the factor to considered for selection of sensors
3) Explain Hall effect transducer

4) Classify Data presentation methods.
5) Explain the data acquisition system with a diagram

6) Compare of Hydraulic and Pneumatic actuators
7) List the advantages and disadvantages of robotic
8) Define PLC and List the applications

9) Analyse ladder diagram for   basic logic gates

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PART– B

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10) (a)	Describe closed loop control system with example .	(5 M)
(b)	Enumerate any 5 measurement versus transduction methods	(5 M)
11) (a)	Explain the working of wheat stone bridge as strain -gauge in null mode	(7 M)
(b)	Briefly explain bimetallic strips	(3 M)
12) (a)	Explain Linear variable differential transformer (LVDT) with a diagram.	(8 M)
(b)	List different types of Light sensor	(2 M)
13) (a)	List different Function of signal conditioning equipment	(6 M)
(b)	Differentiate ADC and DAC	(4 M)
14) (a)	Explain successive approximation type ADC with a neat diagram	(7 M)
(b)	Discuss the necessity of signal conditioning	(3 M)
15) (a)	List the different types of Mechanical actuators	(5 M)
(b)	Sketch and explain the working of solenoid relay.	(4 M)
16) (a)	Describe the working of spool valve with a sketch.	(5 M)
(b)	Explain the working of single rod single acting cylinder	(5M)

17)   Explain the working of automatic camera with a block diagram   (10M)

                                                                                (3 M)
18) (a) Explain the Architecture of PLC with a block diagram   (6 M)
    (b) Explain different operation cycles of PLC   (4 M)

19) (a) Write the general block diagram of MEMS.   (3 M)
    (b) Explain construction and working MEMS accelerometer with a diagram   (7 M)

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