

MECHATRONICS AND IoT

Contents

UNIT 1 SENSORS AND ACTUATORS

UNIT 2 SIGNAL CONDITIONING CIRCUITS AND PLC

UNIT 3 FUNDAMENTALS OF IoT AND EMBEDDED
SYSTEMS

UNIT 4 CONTROLLERS

UNIT 5 MECHATRONICS SYSTEMS AND IoT CASE
STUDIES

UNIT 1 SENSORS AND ACTUATORS 1.00 - 1.151

1.1.	<i>Introduction to mechatronics</i>	1.1
1.1.1.	Evolution or development of mechatronics	1.2
1.1.2.	Elements of mechatronics systems	1.3
1.1.3.	Need for mechatronics	1.5
1.1.4.	Classification of mechatronics	1.6
1.1.5.	Examples of mechatronics systems	1.8
1.1.6.	Advantages and disadvantages of mechatronics systems ...	1.8
1.2.	<i>Modular approach to mechatronics design process</i>	1.9
1.3.	<i>Sensors and transducers</i>	1.11
1.3.1.	Classification of sensors and transducers	1.12
1.3.2.	Static characteristics of sensors	1.15
1.3.3.	Dynamic characteristics of sensors	1.18
1.4.	<i>Resistive transducers</i>	1.19
1.4.1.	Potentiometers	1.20
1.4.2.	Strain gauge	1.23
1.4.3.	Resistive type tactile sensor	1.27
1.4.4.	Resistance Temperature Detectors (RTDs)	1.28
1.4.5.	Thermistors	1.30
1.5.	<i>Capacitive transducers</i>	1.31
1.6.	<i>Inductive transducers</i>	1.34
1.6.1.	Principles of working of inductive transducers	1.34
1.6.2.	Classifications of inductive transducers	1.35
1.6.2.1.	Electrodynamic type inductive transducers	1.35
1.6.2.2.	Electromagnetic type inductive transducers	1.35
1.6.2.3.	Eddy current type inductive transducers	1.36
1.6.2.4.	Variable reluctance type inductive transducers	1.37
1.6.2.5.	Mutual inductance type inductive transducers	1.37
1.6.2.6.	Differential transformer type inductive transducers	1.38
1.6.3.	Advantages, disadvantages and applications of inductive transducers	1.38
1.6.4.	Linear Variable Differential Transformer (LVDT)	1.39
1.6.4.1.	Fluid pressure measurement using LVDT	1.41
1.6.4.2.	Controlling depth of drilled hole in a vertical drilling machine using LVDT	1.42

1.6.5.	Rotational Variable Differential Transformer (RVDT)	1.43
1.6.6.	Eddy current proximity sensor	1.44
1.6.7.	Tachogenerator or Tachometer	1.46
1.7.	Resonant transducers	1.47
1.7.1.	Piezoelectric pressure transducers	1.47
1.7.2.	Piezoelectric tactile transducers	1.49
1.7.3.	Magnetostrictive transducers	1.50
1.8.	Optical sensors	1.51
1.8.1.	Types of optical sensors	1.51
1.8.2.	Photoelectric sensors	1.52
1.8.3.	Photoelectric tachometer	1.53
1.8.4.	Photodetectors or light sensors	1.54
1.8.4.1.	Photoresistor	1.54
1.8.4.2.	Photodiode	1.55
1.8.4.3.	Phototransistor	1.56
1.8.5.	Optical encoders	1.56
1.8.5.1.	Incremental encoder	1.57
1.8.5.2.	Absolute encoder	1.58
1.9.	Vision systems	1.60
1.9.1.	Elements of vision system	1.61
1.9.2.	Working of vision system	1.62
1.9.3.	Applications of vision system	1.65
1.9.4.	Advantages of vision system	1.66
1.10.	Laser sensors	1.66
1.10.1.	Types of laser sensors	1.66
1.10.2.	Laser displacement sensor	1.67
1.10.3.	Applications of laser sensors	1.68
1.10.4.	Advantages and disadvantages of laser sensors	1.68
1.11.	Fibre optic sensors	1.69
1.11.1.	Classifications of fibre optic sensors	1.69
1.11.2.	Advantages and disadvantages of fibre optic sensors	1.72
1.12.	Solid state sensors	1.73
1.12.1.	Classifications of solid-state sensors	1.73
1.12.2.	Thermocouple	1.75
1.12.3.	Piezoresistive pressure sensor	1.78

1.12.4.	Capacitive pressure sensor	1.79
1.12.5.	Optical pressure sensors	1.80
1.12.6.	Humidity sensors	1.81
1.12.7.	Gas sensors	1.83
1.12.8.	Photovoltaic (PV) cells	1.84
1.12.9.	Accelerometer.....	1.86
1.12.10.	Eddy current type inductive proximity sensor	1.88
1.12.11.	Capacitive proximity sensors	1.90
1.12.12.	Optical proximity sensors	1.91
1.12.13.	Ultrasonic sensors	1.92
1.12.14.	Advantages and disadvantages of solid-state sensors	1.94
1.13.	Hall effect sensor	1.95
1.14.	Selection of sensors	1.98
1.15.	Actuators	1.99
1.16.	Electrical motors	1.100
1.16.1.	DC motors	1.102
1.16.2.	Brushless Permanent Magnet DC (BLDC) motor.....	1.104
1.17.	Stepper motors	1.107
1.17.1.	Construction and working of stepper motors	1.107
1.17.2.	Types of stepper motor	1.107
1.17.3.	Variable Reluctance (VR) stepper motor	1.108
1.17.4.	Permanent Magnet (PM) stepper motor	1.109
1.17.5.	Hybrid stepper motor	1.110
1.17.6.	Step modes of stepper motors	1.112
1.17.7.	Specifications of stepper motors	1.112
1.17.8.	Advantages and disadvantages of stepper motors	1.113
1.17.9.	Applications of stepper motors	1.114
1.18.	Servomotors	1.114
1.18.1.	Construction and working principle of servomotor	1.115
1.18.2.	Types of servomotors	1.117
1.18.3.	AC servomotors	1.117
1.18.4.	DC servomotors	1.118
1.18.5.	Performance specifications of servomotor	1.118
1.18.6.	Applications of servomotor	1.119
1.18.7.	Advantages and disadvantages of servomotor	1.119

1.19.	<i>Two mark questions and answers</i>	1.120
1.20.	<i>Solved questions</i>	1.147
<hr/>		
UNIT 2	SIGNAL CONDITIONING CIRCUITS AND PLC	2.00 - 2.130
<hr/>		
2.1.	<i>Operational amplifiers</i>	2.1
2.1.1.	Ideal operational amplifier	2.2
2.1.2.	Inverting amplifier	2.3
2.1.3.	Non-inverting amplifier	2.4
2.1.4.	Summing amplifier	2.4
2.1.5.	Differential amplifier	2.5
2.1.6.	Differentiator amplifier	2.7
2.1.7.	Integrator amplifier	2.7
2.1.8.	Wheatstone bridge amplifier	2.8
2.1.9.	Instrumentation amplifier	2.9
2.2.	<i>PID controller</i>	2.10
2.2.1.	Advantages of PID controller	2.15
2.2.2.	Disadvantages of PID controller	2.15
2.2.3.	Applications of PID controller	2.16
2.3.	<i>Protection circuits</i>	2.17
2.3.1.	Overcurrent protection devices	2.17
2.3.2.	Overvoltage protection devices	2.17
2.4.	<i>Filtering circuits</i>	2.21
2.5.	<i>Multiplexer</i>	2.23
2.6.	<i>Data logger and data acquisition system</i>	2.26
2.7.	<i>Switching loads by power semiconductor devices circuits</i>	2.28
2.7.1.	Diodes	2.28
2.7.2.	Thyristors	2.29
2.7.3.	TRIAC	2.34
2.7.4.	Bipolar transistors	2.36
2.7.5.	Darlington pair	2.38
2.7.6.	MOSFET	2.40
2.7.7.	Relays	2.44
2.8.	<i>Programmable Logic Controller (PLC)</i>	2.46
2.8.1.	Architecture of PLC	2.46
2.8.1.1.	Hardware architecture of PLC	2.47

2.8.1.2.	Internal architecture of PLC	2.49
2.8.2.	Input / output processing	2.53
2.8.3.	Logic ladder programming	2.54
2.8.3.1.	Ladder diagram structure and terminology	2.55
2.8.3.2.	Programming sequence	2.56
2.8.3.3.	Basic ladder symbols	2.56
2.8.3.4.	Construction of ladder diagrams	2.57
2.8.3.5.	Example of simple ladder program	2.57
2.8.3.6.	Logic ladder functions	2.58
2.8.4.	Internal relays or Master Control Relays (MCR)	2.61
2.8.5.	Master Control Relay (MCR)	2.63
2.8.5.1.	Latching	2.63
2.8.5.2.	Sequencing	2.64
2.8.6.	Functional block programming using timers and counters	2.68
2.8.6.1.	Timers	2.68
2.8.6.2.	Counters	2.73
2.8.7.	Jumps	2.76
2.8.8.	Shift registers	2.77
2.8.9.	Data handling and manipulation	2.79
2.8.9.1.	Data transfer operations	2.79
2.8.9.2.	Data compare instructions	2.80
2.8.10.	Arithmetic instructions	2.82
2.8.11.	Example ladder logic programs	2.83
2.8.12.	Solved Anna University Problems.....	2.95
2.9.	<i>Two mark questions and answers</i>	2.108
2.10.	<i>Solved questions</i>	2.126
2.11.	<i>Problems for practice</i>	2.129

UNIT 3 FUNDAMENTALS OF IoT AND EMBEDDED SYSTEMS3.00 - 3.98

3.1.	<i>The internet of things (IoT)</i>	3.1
3.2.	<i>Introduction to IoT framework</i>	3.1
3.2.1.	Popular open-source IoT frameworks	3.2
3.2.2.	Selection of an IoT framework	3.3
3.2.3.	Applications of IoT	3.3
3.2.4.	Features of IoT	3.6

3.3.	<i>IoT enabling technologies</i>	3.6
3.4.	<i>Wireless Sensor Networks (WSN)</i>	3.6
3.4.1.	Characteristics of WSN	3.7
3.4.2.	Significance of WSN	3.8
3.4.3.	Seven concepts related to WSN	3.8
3.4.4.	Components of WSN in IoT	3.10
3.4.5.	IoT and wireless sensor networks	3.10
3.4.6.	Application fields of WSN	3.11
3.4.7.	Advantages and disadvantages of WSN	3.14
3.5.	<i>Cloud computing</i>	3.14
3.5.1.	Cloud computing service models	3.15
3.5.2.	Cloud computing deployment models	3.16
3.5.2.1.	Public cloud	3.17
3.5.2.2.	Private cloud	3.18
3.5.2.3.	Community cloud	3.19
3.5.2.4.	Hybrid cloud	3.20
3.5.2.5.	Difference between public cloud, private cloud and hybrid cloud	3.21
3.5.3.	Benefits of merging IoT and cloud technologies	3.22
3.5.4.	Challenges in combining IoT and cloud technology	3.23
3.5.5.	Future trends in IoT and cloud computing	3.24
3.6.	<i>Bigdata analytics</i>	3.25
3.6.1.	Structure of the big data framework	3.26
3.6.2.	Steps in data analytics framework	3.28
3.6.2.1.	Data collection	3.29
3.6.2.2.	Data cleaning	3.31
3.6.2.3.	Data integration	3.32
3.6.2.4.	Data analysis	3.33
3.6.2.5.	Data visualization	3.35
3.6.2.6.	Alerting	3.37
3.7.	<i>Effective implementation of IoT - Detailed procedure</i>	3.39
3.8.	<i>Embedded systems</i>	3.40
3.8.1.	Working principle of embedded systems	3.42
3.8.2.	Characteristics of embedded systems	3.43
3.8.3.	Basic structure of an embedded system	3.44

3.8.4.	Types of embedded systems	3.46
3.8.5.	Applications of embedded systems	3.49
3.8.6.	Advantages and disadvantages of embedded systems	3.51
3.9.	Single-chip microcontroller system	3.52
3.9.1.	Difference between microcontroller and microprocessor	3.53
3.9.2.	Basic structure of a single-chip microcontroller	3.54
3.9.3.	Selection of microcontrollers	3.55
3.9.4.	Functional block diagram of 8051 microcontroller	3.56
3.9.5.	Pin out description of 8051 microcontroller	3.57
3.9.6.	Components of 8051 microcontroller	3.58
3.10.	Single-board microcontroller systems	3.64
3.10.1.	Basic structure of single-board microcontroller	3.64
3.10.2.	Main features of single-board microcontroller	3.65
3.10.3.	Advantages of single-board microcontroller	3.67
3.10.4.	Applications of single-board microcontroller	3.67
3.11.	Single-board computer systems	3.68
3.11.1.	Components of single-board computer	3.68
3.11.2.	Types of single-board computer	3.70
3.11.3.	Comparison of single-board computer models	3.70
3.11.4.	Input / output devices of single-board computers	3.74
3.11.5.	Network access devices of single-board computers	3.76
3.11.6.	Applications of single-board computers	3.78
3.11.7.	Advantages and disadvantages of a single-board computers ...	3.78
3.11.8.	Difference between a single-board computer and a desktop ...	3.80
3.12.	Embedded system peripherals	3.80
3.13.	Embedded systems: Software considerations	3.85
3.14.	Two mark questions and answers	3.87
3.15.	Solved questions	3.96

UNIT 4 CONTROLLERS 4.00 - 4.118

4.1.	Introduction to programming languages	4.1
4.1.1.	Classification of programming languages	4.2
4.2.	C++	4.3
4.2.1.	Advantages and Disadvantages of C++	4.3
4.3.	Python	4.4

4.3.1.	Features of Python	4.5
4.3.2.	Advantages and disadvantages of Python language	4.6
4.3.3.	Difference Between C++ and Python	4.8
4.4.	<i>Linux operating system</i>	4.9
4.4.1.	Basic features of Linux operating system	4.9
4.4.2.	Architecture of Linux operating system	4.10
4.4.3.	Advantages and disadvantages of Linux operating system ...	4.11
4.5.	<i>Arduino</i>	4.12
4.5.1.	Arduino boards	4.13
4.5.2.	Different types of Arduino boards	4.13
4.5.3.	Features of different types of Arduino boards	4.15
4.5.4.	Components on the Arduino uno board	4.15
4.5.5.	Technical specifications of Arduino uno	4.18
4.5.6.	Arduino uno pinout	4.18
4.5.7.	Arduino peripherals	4.20
4.5.8.	Arduino IDE	4.21
4.6.	<i>ESP8266 Wi-Fi module</i>	4.21
4.6.1.	Features of ESP8266 Wi-Fi module	4.22
4.6.2.	Functional description of ESP8266EX	4.22
4.6.2.1.	CPU, memory and flash	4.24
4.6.2.2.	Clock	4.25
4.6.2.3.	Radio	4.26
4.6.2.4.	Wi-Fi	4.27
4.6.2.5.	Power management	4.28
4.6.2.6.	Applications of ESP8266EX	4.28
4.7.	<i>Interfacing and controlling I/O devices by Arduino</i>	4.29
4.7.1.	Programming fundamentals	4.29
4.7.2.	Coding screen	4.30
4.7.3.	Time in Arduino	4.31
4.7.4.	Pinmode()	4.32
4.7.5.	Digitalwrite()	4.32
4.7.6.	Delay()	4.33
4.8.	<i>Arduino serial communication</i>	4.33
4.8.1.	Serial communication	4.33
4.8.2.	Serial.begin()	4.34

4.8.3.	Arduino serial.print()	4.35
4.8.4.	Serial.print(value)	4.36
4.8.5.	Serial.print(value, format)	4.36
4.8.6.	Flash memory-based strings	4.36
4.8.7.	Serial.println()	4.37
4.8.8.	Difference between serial.print() and serial.println()	4.37
4.9.	Arduino mega board	4.38
4.10.	Arduino push button	4.39
4.10.1.	Structure of pushbutton	4.40
4.11.	Arduino sensors	4.43
4.11.1.	Sensors used in Arduino	4.43
4.11.2.	Types of sensors in Arduino	4.44
4.11.3.	Arduino LDR	4.45
4.11.4.	Arduino ultrasonic distance sensor	4.47
4.11.5.	Arduino ultrasonic range finder	4.51
4.11.6.	Temperature sensor and humidity sensor	4.54
4.12.	Interfacing and controlling sensor and actuator by Arduino	4.58
4.12.1.	Interfacing and controlling stepper motor by Arduino	4.58
4.12.2.	Interfacing and controlling servo motor by Arduino	4.62
4.12.3.	Controlling servomotor using potentiometer by Arduino	4.65
4.13.	The raspberry Pi operating system	4.68
4.13.1.	Features of raspberry Pi	4.68
4.13.2.	Raspberry Pi processor	4.69
4.13.3.	Raspberry Pi boards	4.70
4.13.4.	Types of raspberry Pi boards	4.70
4.13.5.	Raspberry Pi 3 hardware details	4.72
4.13.6.	Raspberry Pi peripherals	4.74
4.14.	Raspberry Pi programming basics	4.76
4.15.	Arduino vs. Raspberry Pi	4.77
4.16.	Interfacing and controlling i/o devices by raspberry Pi	4.78
4.16.1.	Raspberry Pi GPIO access	4.78
4.16.2.	Pin numbering	4.79
4.16.3.	Controlling led with push button using raspberry Pi	4.79
4.17.	Raspberry Pi PWM generation using python and C	4.82
4.17.1.	Introduction to PWM	4.82

4.17.2.	Raspberry Pi PWM	4.82
4.17.3.	Led interfacing with raspberry Pi	4.83
4.17.4.	PWM functions in Python	4.84
4.17.4.1.	Create PWM object	4.84
4.17.4.2.	Python based I2C functions for raspberry Pi	4.85
4.18.	<i>Sensors in raspberry Pi</i>	4.86
4.18.1.	Accelerometer and gyroscope sensor interfacing with raspberry Pi	4.87
4.18.2.	Humidity and temperature sensor interfacing with raspberry Pi	4.90
4.18.3.	Pir motion sensor interfacing with raspberry Pi using python ...	4.94
4.18.4.	Interfacing light intensity sensor with raspberry Pi	4.96
4.18.5.	Interfacing ultrasonic distance sensor with raspberry Pi	4.98
4.19.	<i>Sensor and actuator interactions with raspberry Pi</i>	4.102
4.19.1.	Stepper motor interactions with raspberry Pi	4.102
4.19.2.	Servo motor interfacing with raspberry Pi	4.104
4.20.	<i>Two mark questions and answers</i>	4.108
4.21.	<i>Solved questions</i>	4.115

UNIT 5 MECHATRONICS SYSTEMS AND IoT CASE STUDIES 5.00 - 5.112

5.1.	<i>Introduction to mechatronics systems</i>	5.1
5.2.	<i>Mechatronics applications</i>	5.1
5.3.	<i>Drone actuation and control</i>	5.2
5.3.1.	Components of quadcopter drone	5.3
5.3.2.	Circuit diagram of drone using Arduino	5.8
5.3.3.	Working of drone control system	5.11
5.3.4.	Applications of drone control systems	5.12
5.3.5.	Advantages and disadvantages of drones	5.13
5.4.	<i>Autonomous robots with vision system</i>	5.14
5.4.1.	Components of autonomous robot system	5.14
5.4.2.	System operation of autonomous mobile robot	5.17
5.4.3.	Circuit diagram of autonomous mobile robot	5.18
5.4.4.	Advantages of autonomous robots with vision systems ...	5.19
5.4.5.	Disadvantages of autonomous robots with vision systems ...	5.20
5.5.	<i>Automotive mechatronics</i>	5.20

5.5.1.	Evolution of automotive mechatronics	5.21
5.6.	<i>Electronic ignition system</i>	5.21
5.6.1.	Principle of electric ignition system	5.22
5.6.2.	Components of electronic ignition system	5.22
5.6.3.	Working principle of electronic ignition system	5.24
5.6.4.	Applications of electronic ignition system	5.25
5.6.5.	Advantages of electronic ignition system	5.25
5.6.6.	Disadvantages of electronic ignition system	5.26
5.7.	<i>Anti-lock Braking System (ABS)</i>	5.26
5.7.1.	Need of ABS in automobiles	5.26
5.7.2.	Components of ABS	5.27
5.7.3.	Working of ABS	5.30
5.7.4.	Classification of anti-lock braking system	5.31
5.7.5.	Advantages of anti-lock braking system	5.32
5.7.6.	Disadvantages of anti-lock braking system	5.33
5.7.7.	Applications of anti-lock braking system	5.33
5.8.	<i>Electronic Brake force Distribution (EBD)</i>	5.34
5.8.1.	Components of EBD	5.34
5.8.2.	Working of EBD	5.36
5.8.3.	Advantages of EBD	5.37
5.9.	<i>Adaptive cruise control</i>	5.38
5.9.1.	Uses of adaptive cruise control	5.38
5.9.2.	Components of adaptive cruise control	5.41
5.9.3.	Working of adaptive cruise control	5.43
5.9.4.	Advantages of adaptive cruise control	5.44
5.9.5.	Disadvantages of adaptive cruise control	5.45
5.10.	<i>Introduction to IoT case studies</i>	5.45
5.10.1.	Components of IoT	5.46
5.10.2.	Applications and advantages of IoT	5.48
5.11.	<i>Remote monitoring systems</i>	5.50
5.11.1.	Introduction	5.50
5.11.2.	Working of remote monitoring system	5.51
5.11.3.	Remote asset management via IoT platforms	5.51
5.11.4.	IoT remote monitoring use cases	5.52
5.11.5.	Advantages of IoT remote monitoring	5.52

	5.11.6. Disadvantages of IoT remote monitoring	5.53
5.12.	<i>Case study 1: IoT-based smart home automation system</i>	5.54
	5.12.1. Introduction	5.54
	5.12.2. Inputs, outputs and working principle of various modules ...	5.54
	5.12.3. Working IoT-based smart home automation system	5.60
5.13.	<i>Case study 2: Remote health monitoring system using IoT</i>	5.62
	5.13.1. Components of remote health monitoring system.....	5.62
	5.13.2. Flow diagram of health monitoring systems	5.65
	5.13.3. Working of remote health monitoring systems	5.65
	5.13.4. Advantages of remote health monitoring systems.....	5.66
	5.13.5. Disadvantages of remote health monitoring systems	5.66
5.14.	<i>Case study 3: Remotely Operated Autonomous System (ROAS)</i>	5.67
	5.14.1. Key characteristics of ROAS	5.67
	5.14.2. Applications of ROAS	5.68
	5.14.3. Components of ROAS	5.68
	5.14.4. IoT-enabled Remotely Operated Underwater Vehicle (ROUV)..	5.71
	5.14.5. IoT-enabled autonomous vehicle systems	5.73
	5.14.5.1. Key technologies for autonomous vehicle systems	5.74
	5.14.5.2. Components of autonomous vehicle systems	5.74
	5.14.5.3. Advantages of autonomous vehicle systems	5.76
	5.14.5.4. Disadvantages of autonomous vehicle systems	5.76
5.15.	<i>Case study 4: Centralized water management system</i>	5.77
	5.15.1. Key aspects of Centralized Water Management System (CWMS)	5.77
	5.15.2. IoT-based smart water management systems	5.79
	5.15.3. Components of IoT-based smart water management system ..	5.79
	5.15.4. Working of IoT-based smart water management system	5.81
	5.15.5. Advantages of centralized water management system	5.85
	5.15.6. Disadvantages of centralized water management system	5.85
5.16.	<i>Case study 5 IoT-enabled Robotic Camera Dolly (IRCD)</i>	5.86
	5.16.1. Features and benefits of IoT-enabled Robotic Camera Dolly (IRCD)	5.86
	5.16.2. Components of IoT enabled robotic camera dolly	5.88
	5.16.3. Working of the IRCD system.....	5.89
	5.16.4. Workflow – scenario	5.90
	5.16.5. Advantages of IRCD	5.91

5.16.6.	Disadvantages of IRCD	5.91
5.17.	Case study 6: IoT-based smart agriculture system	5.92
5.17.1.	Features of IoT-based smart agriculture system	5.93
5.17.2.	Components of IoT-based smart agriculture system	5.94
5.17.3.	Working of IoT-based smart agriculture system	5.96
5.17.4.	Advantages of IoT-based smart agriculture system	5.97
5.17.5.	Disadvantages of IoT-based smart agriculture system	5.97
5.18.	Case study 7: IoT-based vehicle management system.....	5.98
5.18.1.	Key functionalities of IoT-based vehicle management system..	5.99
5.18.2.	Components of IoT-based vehicle management system ...	5.100
5.18.3.	IoT-based smart car parking system	5.103
5.18.4.	Working of IoT-based smart car parking system	5.104
5.18.5.	Advantages of IoT-vehicle management system	5.105
5.18.6.	Disadvantages of IoT-vehicle management system	5.106
5.19.	Two mark questions and answers	5.107
5.20.	Solved questions	5.110

Solved Anna University Model Question Papers

MQ-1
