

### 3.1 BASICS OF CONTROL SYSTEM

L T P  
4 - 3

#### RATIONALE

It is pre-requisite for the students to know the various plant controls in the process industry. An automatic control system saves manpower, reduces cost of production, increases the accuracy of the finished product and helps in mass production. The knowledge of this subject is required to have deeper grasp of the control environment/techniques as need to be studied in the forthcoming subjects e.g. process control, process instrumentation.

#### DETAILED CONTENTS

1. Introduction (16 hrs)  
Basic elements of control system, open loop control system, closed loop control system, control system terminology, manually controlled closed loop systems, on/off and continuous control, automatic controlled closed loop systems, basic elements of a servo mechanism, Examples of automatic control systems, use of equivalent systems for system analysis, linear systems, non-linear systems, control system examples from chemical systems, mechanical systems, electrical systems, introduction to laplace transform.
2. Transfer function (12 hrs)  
Transfer function analysis of ac and dc servomotors synchros, stepper motor, amplydyne. ac position control system, magnetic amplifier.
3. Control system representation (12 hrs)  
Transfer function, block diagram, reduction of block diagram, problems on block diagram, Mason's formula signal flow graph
4. Time Response Analysis (12 hrs)  
Standard test signals, time response of first and second-order system, time constant, time response of second order system, time response specifications, steady-state errors and error constants, problems in first and second order system.
5. Stability (12 hrs)  
Routh Hurwitz Criterion, Root Locus

## LIST OF PRACTICALS

1. Study of characteristic of servomotor
2. Characteristics and speed control of a stepper motor
3. To demonstrate the synchro characteristic and use a synchro pair as error detector
4. Measurement of speed control of motor with tachometric feed back.
5. Study of a DC speed control system
6. Simulation of a position control system with PC
7. Study of ON-OFF controller

## INSRUNCTIONAL STRATEGY

Since the knowledge of this subject is required to have deeper grasp of the control environment/techniques as need to be studied in the forthcoming subjects e.g. process control, process instrumentation, the subject teacher is required to make the subject interesting and provide information about practical applications. The students may be given exposure in process industry and shown various controls.

## RECOMMENDED BOOKS

- 1) Control Systems by Nagrath and Gopal, Wiley Publishers
- 2) Control Systems Engineering by Bhattacharya, Pearson Education, Sector 62, Noida
- 3) Control Systems by KUO
- 4) Control Systems by Ogata, Pearson Education
- 5) B. S. Manke

## SUGGESTED DISTRIBUTION OF MARKS

Sr No	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2.	12	15
3.	12	20
4.	12	20
5.	12	20
<b>Total</b>	<b>64</b>	<b>100</b>

## 3.2 ELECTRICAL AND ELECTRONICS MATERIALS AND COMPONENTS

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### RATIONALE

A diploma holder will be involved in maintenance, repair and production of electrical equipment and systems. In addition, he may be required to procure, inspect and test electrical and electronic engineering materials. Knowledge of various types of materials will be needed in order to execute the above-mentioned functions. He may also have to decide for an alternative when a particular material is either not readily available in the market or its cost becomes prohibitive.

### DETAILED CONTENTS

1. **Materials**
- 1.1 Classification of materials (04 hrs)  
Conducting, semi-conducting and insulating materials through a brief reference to their atomic structure and energy bands.
- 1.2 Conducting Materials (08 hrs)
  - Resistors and factors affecting resistivity such as temperature, alloying and mechanical stressing. Classification of conducting materials as low resistivity and high resistivity materials.
  - Applications of Copper, Aluminium, Steel, low resistivity copper alloys such as brass, bronze, copper graphite etc in the field of electrical engineering.
  - Superconductivity and piezoelectric ceramic materials
- 1.3 Insulating Materials (06 hrs)  
Important relevant characteristics (electrical, mechanical and thermal) and applications of the following material:  
  
Mica, Glass, Copper, Silver, PVC, Silicon, Rubber, Bakelite, Cotton, Ceramic, Polyester, Polythene and Varnish.
- 1.4 Magnetic Materials (06 hrs)  
Different Magnetic materials; (Dia, Para, Ferro) and their properties. Ferro magnetism, Domains, permeability, Hysteresis loop. Soft and hard magnetic materials, their examples and typical applications.
- 1.5. Special Materials (04 hrs)  
Thermocouple, bimetals, lead soldering and fuse material, mention their applications
- 1.6. Introduction of various engineering materials necessary for fabrication of electrical machines such as motors, generators, transformers etc (04 hrs)

## 2. Components

- 2.1 Capacitors (08 hrs)
- Concept of capacitance and capacitors, units of capacitance, types of capacitors, constructional details and testing specifications
  - Capacity of parallel plate capacitors, spherical capacitors, cylindrical capacitor.
  - Energy stored in a capacitor.
  - Concept of di-electric and its effects on capacitance, di-electric constant, break down voltage.
  - Series and parallel combination of capacitor. Simple numerical problems of capacitor.
  - Charging and discharging of capacitor with different resistances in circuit, concept of current growth and decay, time constant in R-C circuits, simple problems.
- 2.2 Resistors: Carbon film, metal film, carbon composition, wound and variable types (presets and potentiometers), colour coding (4 hrs)
- 2.3 Transformer, inductors and RF coils: (4 hrs)  
Methods of manufacture, testing, Need of shielding, application and trouble shooting
- 2.4 Surface Mounted Devices (SMDs): (4 hrs)  
Constructional detail and specifications.
- 2.5 Connectors, Relays, switches and cables: (4 hrs)  
Different types of connectors, relays, switches and cables, their symbols, construction and characteristics.
- 2.6 Semi Conductors and Integrated Circuits (ICs) - Characteristics and testing (08 hrs)
- Basic characteristics of semiconductor materials, testing of diodes, transistors, FETs and SCRs.
  - Various processes in IC manufacturing. Hybrid IC technology.

### INSTRUCTIONAL STRATEGY

The teacher should bring different materials, electronic components and devices in the class while taking lectures and explain and make students familiar with them. Also he may give emphasis on practical applications of these devices and components in the field. In addition, the students should be given exercises on identification of materials used in various electronic gadgets etc .and be encouraged to do practical work independently and confidently.

**RECOMMENDED BOOKS**

1. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi
2. Electronic Components and Materials by Grover and Jamwal, Dhanpat Rai and Co., New Delhi
3. Electrical Engineering Materials by Sahdev, Unique International Publications
4. Electronic Components and Materials by SM Dhir, Tata Mc Graw Hill, New Delhi
5. Electrical Engineering Materials by PL Kapoor, Khanna Publishers, New Delhi
6. Electrical and Electronics Engineering Materials BR Sharma and Others, Satya Parkashan, New Delhi
7. Electrical and Electronics Engineering Materials DR Arora, Ishan Publications, Ambala City
8. Electrical Engineering Materials by Rakesh Dogra, SK Kataria and Sons, New Delhi
9. Electronic Devices and Linear Circuits by MM Bhargava and Gupta; McGraw Hill
10. Basic Electronics by VK Mehta; S Chand Pulishers

**SUGGESTED DISTRIBUTION OF MARKS**

<b>Sr No</b>	<b>Time Allotted (Hrs)</b>	<b>Marks Allotted (%)</b>
1.1	4	5
1.2	8	15
1.3	6	10
1.4	6	10
1.5	4	5
1.6	4	5
2.1	8	20
2.2	4	5
2.3	4	5
2.4	4	5
2.5	4	5
2.6	8	10
<b>Total</b>	<b>64</b>	<b>100</b>

### 3.3 ELECTRONIC INSTRUMENTS AND MEASUREMENTS

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#### RATIONALE

In the real world of work the technician is required to handle wide variety of instruments while testing, trouble shooting, calibration etc. the study of this subject will help students to gain the knowledge of working principles and operation of different instruments. During practical sessions, he will acquire the requisite skills.

#### DETAILED CONTENTS

1. Basics of Measurements (04 hrs)
 

Measurement, methods of measurement, types of instruments  
Specifications of instruments: Accuracy, precision, sensitivity, resolution, range, Errors in measurement, sources of errors, limiting errors, Loading effect, Importance and applications of standards and calibration
2. Voltage, Current and Resistance Measurement (12 hrs)
  - Principles of operation and construction of permanent magnet moving coil (PMMC) instruments.
  - Moving iron type instruments, measurement of D.C voltage and current, Block diagram, working principle, application and comparison of analog and digital Multimeter.
  - Specifications of multimeter and its applications.
  - Limitations with regard to frequency and input impedance.
3. Cathode Ray Oscilloscope (10 hrs)
  - Construction and working of Cathode Ray Tube(CRT)
  - Time base operation and need for blanking during flyback, synchronization
  - Block diagram, description of a basic CRO and triggered sweep oscilloscope, front panel controls.
  - Specifications of CRO and their explanation.
  - Measurement of voltage, current, frequency, time period and phase using CRO.
  - CRO probes, special features of dual beam, dual trace, delay sweep.
  - Digital storage oscilloscope (DSO) : block diagram and working principle.

4. Signal Generators and Analytical Instruments (06 hrs)
- Explanation of block diagram specifications of low frequency and RF generators, pulse generator, function generator
  - Wave analyzer, distortion measurement and spectrum analyser
5. Impedance Bridges and Q Meters (10 hrs)
- Wheat stone bridge
  - AC bridges: Maxwell's induction bridge, Hay's bridge, De-Sauty's bridge, Schering bridge and Anderson bridge
  - Block diagram description of laboratory type RLC bridge, specifications of RLC bridge
  - Block diagram and working principle of Q meter
6. Digital Instruments (06 hrs)
- 6.1 Comparison of analog and digital instruments
  - 6.2 Working principle of ramp, dual slope and integration type digital voltmeter
  - 6.3 Measurement of time interval, time period and frequency using universal counter/frequency counter
  - 6.4 Working principle of logic probe, logic pulser, logic analyzer, logic comparator, signature analyzer

### LIST OF PRACTICALS

1. Measurement of voltage, resistance, frequency, using digital multimeter
2. Measurement of voltage, frequency, time period and phase using CRO
3. Measurement of voltage, frequency, time and phase using DSO
4. Interfacing of DSO with printer.
5. Measurement of rise time and fall time using DSO
6. Measurement of Q of a coil and its dependence on frequency
7. Measurement of resistance and inductance of coil using RLC Bridge
8. Use of logic pulser and logic probe
9. Measurement of time period, frequency, average period using universal counter/ frequency counter
10. Measurement of Impedance using Maxwell Induction Bridge
11. To find the value of unknown resistance using Wheat Stone Bridge

## INSTRUCTIONAL STRATEGY

The subject requires both theory and practical emphasis simultaneously, so that the student can understand the practical significance of the various areas. Visits to instrumentation and communications industries must be carried out, so as to make the students can understand where and how the various instruments are used in the industry.

## RECOMMENDED BOOKS

1. Electronics Measurement and Instrumentation by AK Sawhney, Dhanpat Rai and Sons, New Delhi
2. Electronics Measurement and Instrumentation by Oliver, Tata McGraw Hill Education Pvt Ltd, New Delhi
3. Electronics Instrumentation by Cooper, Prentice Hall of India, New Delhi
4. Electronics Test and Instrumentation by Yashpal and Sanjeev Kumar, North Publications, Jalandhar
5. Electronics Instrumentation by JB Gupta, Satya Prakashan, New Delhi

## SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (hrs)	Marks Allocation%
1.	04	5
2.	12	20
3.	10	20
4.	06	15
5.	10	20
6.	06	20
<b>Total</b>	<b>48</b>	<b>100</b>



### 3.4 PRINCIPLES OF INSTRUMENTATION

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#### RATIONALE

This syllabus has been designed to impart the knowledge of basic principles involved in instrumentation systems. The student will learn the various characteristics of instruments, means of transduction and displaying variables besides instrument selection criteria. The concepts will help the students in forming a solid foundation for higher learning.

#### DETAILED CONTENTS

1. Basics of Instrumentation Systems (08 hrs)
  - Scope and necessity of instruments
  - Measurement, its significance and types
  - Building blocks of instrumentation systems
  - Various testing signals
  - Important process variables and their units
  
2. Performance Characteristics of Instruments (16 hrs)
  - Static characteristics of instruments-accuracy, precision, linearity, resolution, sensitivity, hysteresis, drift, dead time, loading effects.
  - Dynamic inputs and dynamic characteristics-time constant, response time, natural frequency, damping coefficient.
  - Reliability, serviceability, cost effectiveness, and availability
  - Static and dynamic response (step response)
  - Order of Instruments
  - Environmental Effects
  - Calibration tools
  
3. Display and recording devices (18 hrs)
  - Operating mechanism in indicating and recording devices
  - Various indicating, integrating and recording methods and their combination
  - Merits and demerits of circular chart and strip chart recorder

- Basics of printing devices
- Scanning, data logging and field buses
- Bar graph LCD, Seven segment display, X-Y recorder, scanners
- Design experiments for display system

4. Errors (06 hrs)

- Calibration of instruments
- Sources of errors
- Classification of errors
- Grounding/earthing
- Precautions

### LIST OF PRACTICALS

1. To find the constant of 1<sup>st</sup> order instrument
2. To find the constant of 2<sup>nd</sup> order instrument
3. To find the response of 1<sup>st</sup> order instrument with step, sinusoidal and ramp input
4. To find the response of 2<sup>nd</sup> order instrument with step, sinusoidal and ramp input
5. To assemble seven segment display using LEDs
6. To make fourteen segments display using LCD and verify it
7. To make the DOT Matrix display and its verification
8. Make any word using LCD and LED
9. To study circular and strip chart recorder

### INSTRUCTIONAL STRATEGY

This being a first branch specific subject, the teacher should lay emphasis on giving an overview of the field of instrumentation and control. In addition, for exposure the students should be taken to various process industries or where control system and electronic instrumentation is being used. The teacher shall demonstrate the instruments and their functioning.

### LIST OF RECOMMENDED BOOKS

1. Mechanical and Industrial Measurement by RK Jain, Khanna Publishers, New Delhi
2. Electrical and Electronic Measurement and Instrumentation by AK Sawhney, Dhanpat Rai and Co., New Delhi

3. Elements of Electronic Instrumentation and measurement by Carr, Pearson Education , Sector 62, Noida
4. Electronic Instrumentation and measurement by Kishore, Pearson Education , Sector 62, Noida
5. Electrical and Electronic Measurement and Instrumentation by JB Gupta; S.K Kataria and Sons Publishers, New Delhi
6. Measurement Systems by EO Doebelin.
7. Industrial Instrumentation by Donald P Eickrman
8. Advanced Instrumentation and Control by MF Kureshi

#### **SUGGESTED DISTRIBUTION OF MARKS**

<b>Topics</b>	<b>Time Allotted (hrs)</b>	<b>Marks Allocation</b>
1.	8	15
2.	16	35
3.	18	40
4.	6	10
<b>Total</b>	<b>48</b>	<b>100</b>

### 3.5 ELECTRICAL MACHINES

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#### RATIONALE

This subject deals with various types of electrical machines being employed in industry, power stations, domestic and commercial appliances etc. It is envisaged that after studying the subject, students will gain competence in operation, repair and maintenance of such machines and give suggestions for improvement in their performance. The students will study three phase supply, transformer, a.c. and d.c. motors. The practicals will enable students to perform various tests necessary for installation and commissioning of such machines.

#### DETAILED CONTENT

1. Three Phase Supply (06 hrs)
  - a) Advantages of 3 phase system over single phase system
  - b) Star delta connections
  - c) Relation between phase voltage and line voltage, phase current and line current in a 3 phase system
  - d) Power and power factor(p.f.) in 3 phase system and their measurements, importance of p.f. (simple problems)
  
2. Transformer (08 hrs)
 

Principle of transformer, construction, voltage and current transformation. Methods of connection in 3 phase transformers, current and voltage relationship, auto transformer and its uses, instrument transformer, voltage regulation and its significance, need for isolation, electrical and transients suppression, principles of isolation transformer, specifications of all types of transformers. Losses in a transformer
  
3. DC Motor (08 hrs)
 

Principle, significance of back emf, types of motors and their construction, motor characteristics for shunt and series, speed control of DC motors and factors controlling the speed. Starting methods, construction and working of 3 point starter, applications (simple problems)

4. Three Phase Induction Motors (08 hrs)

Principle, construction, concept of slip, torque and characteristics, effect of motor resistance on torque (running and starting), rotor current, output power, different methods of speed control. Starting methods and constructional and working of 3 point starter, applications (simple problems)

5. Synchronous Motors (06 hrs)

Principle, construction and working, effect of load and excitation on synchronous motor. Starting of motor and their applications

6. Single Phase Motors (06 hrs)

Principle, construction, working speed, control, starting and applications of the following motors:

- a) Induction motor
- b) Universal motor

7. Stepper Motor and Servo Motor (06 hrs)

Types, construction, working and their applications

**(Note:** No derivation of any formula)

### LIST OF PRACTICALS

The students to perform following experiments in the lab:

1. DC machines

- 1.1 Speed control of dc shunt motor (i) Armature control method (ii) Field control method
- 1.2 Study of dc series motor with starter (to operate the motor on no load for a moment)

2. Transformers (single phase)

Open circuit and short circuit test for determining parameter of a transformer

3. Determining the regulation and efficiency from the data obtained from open circuit and short circuit test

4. Three-phase transformers

Checking the polarity of the windings of a three phase transformer and connecting the windings in various configurations

5. To measure power and power factors in 3 - phase load using two wattmeter method.

6. To connect a dc shunt motor with supply through 3 - phase starter and to run the motor at different speed with the help of a field regulator.

7. To run a 3 - phase squirrel cage Induction motor with the help of a star delta starter.

8. To change the direction of rotation of induction motor.

9. To run a synchronous motor with a.c. supply and to measure speed to verify the relation

$$N = \frac{120f}{p}$$

### INSTRUCTIONAL STRATEGY

For conceptual understanding a field/industrial visit (preferably Transformer Factory) may be organised to give live exposure to students. For this the teacher should visit first to understand the assembly line-up which could be followed by a visit of the students, where the teacher can give an idea of the working of the factory without much seeking assistance of the factory staff. In addition, emphasis may be given on field applications and simple numerical problems.

### RECOMMENDED BOOKS

- 1) Electrical Machine by SK Bhattacharya, Tata McGraw Hill Education Pvt Ltd, New Delhi
- 2) Electrical Machines by Nagrath and Kothari, Tata McGraw Hill Education Pvt Ltd, New Delhi
- 3) Experiments in Basic Electrical Engineering: by S.K. Bhattacharya, KM Rastogi: New Age International (P) Ltd. Publishers, New Delhi
- 4) Electrical Machines by SK Sahdev, Uneek Publications, Jalandhar
- 5) Electrical Engineering by JB Gupta, SK Kataria & Sons, New Delhi
- 6) Electrical Machines by DR Arora, Ishan Publications, Ambala City.
- 7) Electrical Technology Vol. - I and II B.L. Thareja, S Chand and Co. New Delhi

**SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER**

<b>Sr. No.</b>	<b>Topic</b>	<b>Time Allotted (hrs)</b>	<b>Marks Allocation</b>
1.	Three phase Supply	6	12
2.	Transformers	8	20
3.	DC Motor	8	15
4.	3 Phase Induction Motors	8	20
5.	Synchronous Motors	6	10
6.	Single Phase Motors	6	13
7.	Stepper Motor and Servo Motor	6	10
<b>Total</b>		<b>48</b>	<b>100</b>

### 3.6 FUNDAMENTALS OF DIGITAL ELECTRONICS

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#### RATIONALE

This syllabus has been designed to make the students know about the fundamental principles of digital electronics and gain familiarity with the available IC chips. This subject aims to give a background in the broad field of digital systems design and microprocessors.

#### DETAILED CONTENTS

1. Introduction (02 hrs)
  - a) Distinction between analog and digital signal.
  - b) Applications and advantages of digital signals.
2. Number System (04 hrs)
  - a) Binary, octal and hexadecimal number system: conversion from decimal and hexadecimal to binary and vice-versa.
  - b) Binary addition, subtraction, multiplication and division including binary points. 1's and 2's complement method of addition/subtraction, sign magnitude method of representation, floating point representation
3. Codes and Parity (04 hrs)
  - a) Concept of code, weighted and non-weighted codes, examples of 8421, BCD, excess-3 and Gray code.
  - b) Concept of parity, single and double parity and error detection
  - c) Alpha numeric codes: ASCII and EBCDIC.
4. Logic Gates and Families (06 hrs)
  - a) Concept of negative and positive logic
  - b) Definition, symbols and truth tables of NOT, AND, OR, NAND, NOR, EXOR Gates, NAND and NOR as universal gates.
  - (c) Introduction to Logic families and digital IC's
5. Logic Simplification (06 hrs)
  - a) Postulates of Boolean algebra, De Morgan's Theorems. Various identities. Formulation of truth table and Boolean equation for simple problem. Implementation of Boolean (logic) equation with gates



- b) Karnaugh map (upto 4 variables) and simple application in developing combinational logic circuits
6. Arithmetic circuits (04 hrs)
- Definition of combinational circuit
  - Half adder and Full adder circuit, design and implementation.
  - Half and Full subtracter circuit, design and implementation.
  - 4 bit adder/subtracter.
  - Encoder – Decimal to BCD and BCD to Decimal
7. Decoders, Multiplexers and De Multiplexers (04 hrs)
- Four bit decoder circuits for 7 segment display
  - Basic functions and block diagram of MUX and DEMUX
  - Implementation of 4:1 mux and 4:1 demux
8. Sequential Circuits (04 hrs)
- Difference between combinational and sequential circuits
  - Concept and types of latch with their working and applications
  - Operation using waveforms and truth tables of RS, T, D, Master/Slave JK flip flops.
  - Difference between a latch and a flip flop
9. Counters (06 hrs)
- Introduction to Asynchronous and Synchronous counters
  - Binary counters
  - Divide by N ripple counters, Decade counter.
  - Pre settable and programmable counters
  - Up/down counter
  - Ring counter with timing diagram
10. Shift Register (06 hrs)
- Introduction and basic concepts including shift left and shift right.
- Serial in parallel out, serial in serial out, parallel in serial out, parallel in parallel out.
  - Universal shift register
  - Buffer register, Tristate Buffer register
11. A/D and D/A Converters (02 hrs)
- Working principle of A/D and D/A converters
  - Applications of A/D and D/A converter.

## LIST OF PRACTICALS

1. Basic logic operations, AND, OR, NOT functions
2. Verification and interpretation of truth tables for AND, OR, NOT NAND, NOR and Exclusive OR (EXOR) and Exclusive NOR(EXNOR) gates
3.
  - Realisation of logic functions with the help of NAND or NOR gates
  - Design of a NOR gate latch and verification of its operation
4. To design a half adder using XOR and NAND gates and verification of its operation  
Construction of a full adder circuit using XOR and NAND gates and verify its operation
5. Verify a full subtractor with its truth table
6. Verification of truth table for encoder and decoder
7. Verification of truth table for Mux and DeMux
8. To design a 4 bit SISO, SIPO, PISO, PIPO shift registers using JK/D flip flops and verification of their operation.
9. To design a 4 bit ring counter and verify its operation.
10. Use of digital IC tester for testing of different ICs

## INSTRUCTIONAL STRATEGY

The digital systems in microprocessors have significant importance in the area of electronics. Adequate competency needs to be developed by giving sufficient practical knowledge in microprocessors (programming as well as interfacing), A/D, D/A Converters and other topics. Help may be taken in the form of charts, simulation packages to develop clear concepts of the subject. Programming exercises other than the tested in circulation may be given to the students.

## RECOMMENDED BOOKS

1. Digital Electronics and Applications by Malvino Leach, Tata McGraw Hill Education Pvt Ltd, New Delhi
2. Digital Logic Designs by Morris Mano, Prentice Hall of India, New Delhi
3. Digital Electronics by Soumitra Kumar Mandal, Tata McGraw Hill Education Pvt Ltd,
4. Digital Electronics by V K Sangar , Raj Publishers, Jalandhar
5. Digital Electronics by Tokheim, Tata McGraw Hill Education Pvt Ltd,
6. Digital Fundamentals by Thomas Floyds, Universal Book Stall
7. Digital Electronics by RP Jain, Tata McGraw Hill Education Pvt Ltd, New Delhi
8. Digital Electronics by KS Jamwal, Dhanpat Rai and Co., New Delhi
9. Digital Electronics by Rajiv Sapra, Ishan Publication, Ambala

10. Digital Electronics by BR Gupta, Dhanpat Rai & Co., New Delhi
11. Digital Systems: Principles and Applications by RJ Tocci, Prentice Hall of India, New Delhi
12. Digital Electronics by Rajaraman V., Prentice Hall of India, New Delhi
13. Fundamentals of Digital Electronics by Naresh Gupta, Jain Brothers, New Delhi

### SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Hrs)	Marks Allotted (%)
1.	2	5
2.	4	5
3.	4	5
4.	6	15
5.	6	10
6.	4	10
7.	4	10
8.	4	10
9	6	15
10.	6	10
11.	2	5
<b>Total</b>	<b>48</b>	<b>100</b>