Category I

BSc. (Hons.) Instrumentation

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : Fundamentals of Digital Circuits

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Digital Circuits	4	3	0	1	Class XII pass with Science	Nil

Learning Objectives

- To impart the knowledge of Number systems and codes.
- To familiarize with concepts of Boolean algebra, logic gates.
- To minimise and design various combinational logic circuits.
- To develop the basic understanding of flip flops and use them to design sequential circuits.
- To differentiate between various digital logic families.

Learning outcomes

At the end of this course, students will be able to

Learn various number systems, binary codes and concepts of Boolean algebra.
Apply the knowledge of Boolean algebra to solve real time problems and determine how to interconnect logic gates to convert the circuit input signals to desired output signals.
Analyse the combinational and sequential circuits using flip flops and show how they can be used for designing various types of digital circuits used for processing and transmission of data.
Compare various digital logic families with respect to their speed, power consumption and cost

SYLLABUS OF DSC-4

Unit-1 **(09 Hours)**

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems,

base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code, gray code, excess-3 code.

Unit-2 **(12 Hours)**

Boolean algebra and Logic Gates: Introduction to Boolean Algebra and Boolean operators, Basic postulates and fundamental theorems of Boolean algebra, construction, and symbolic representation of OR, AND, NOT, XOR, XNOR Gate, Truth Tables, Universal (NOR and NAND) gates.

Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, TTL and CMOS families and their comparison.

Unit-3 **(12 Hours)**

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor, parallel adder/subtractor.

Unit-4 **(12 Hours)**

Sequential logic design: Latches and Flip-flops, S-R Flip flop, J-K Flip flop, T and D type Flip flop, Clocked and edge triggered Flip flops, master slave Flip flop, Registers, Counters (synchronous and asynchronous and modulo-N), State Table, State Diagrams, counter design using excitation table and equations, Ring counter and Johnson counter.

Programmable Logic Devices: Basic concepts- ROM, PLA, PAL, CPLD, FPGA

Practical component (if any) – Fundamentals of Digital Circuits Lab – 30 Hours

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate ICs.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a Seven Segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. Design a 2 X 4 Decoder using gates.
8. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
9. Design a counter using D/T/JK Flip-Flop.
10. Design a shift register and study Serial and parallel shifting of data.

Essential/recommended readings

1. M. Morris Mano, Digital Logic & Computer Design, Pearson Education Asia (2016)

2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Limited, 11th Edition, Global Edition (2015)
3. Kumar A. Anand, Fundamentals of Digital Circuits, 3rd Edition (2014), PHI Learning Private Ltd.
4. R. J. Tocci, Neal.SWindmer, Gregory L Moss, Digital Systems, Principles and Applications, 10th Edition, Pearson (2009)

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): Sensors and Actuators

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sensors and Actuators	4	2	0	2	Class XII pass with Science	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To study different types of transducers – resistive, capacitive, inductive, light and temperature
- Be conversant in construction and working of various pressure and flow measuring instruments
- Get an exposure to actuators, micro actuators, and their different types

Learning outcomes

At the end of this course, students will be able to

Identify and comprehend various sensors used in the real-life applications and paraphrase their importance

Classify and explain with examples of transducers, including those for measurement of temperature, strain, light, capacitance and inductance

Be conversant in construction and working of various pressure and flow measurement devices used for industrial purposes

Classify and explain the different types of actuators
To study various processing techniques of micro actuators

SYLLABUS

Unit 1 **(7 Hours)**

Classification of transducers: Active, Passive, Mechanical, Electrical and their comparison. Selection of Transducers, Principle and working of following types: Resistive (Strain Gauge), Capacitive, Inductive (LVDT), Piezoelectric, light (photo-conductive, photovoltaic, LDR), Temperature (RTD, Thermocouple, Thermistor)

Unit 2 **(7 Hours)**

Sensors in nature (Vision, Hearing, touch, and smell) and how we can learn from nature. Principles of Sensing, Classification and Terminology of Sensors, Measurands. Some basic discussion about electric field, potential, capacitance, resistance etc. Biomedical sensor, Mechanical Sensors, Acoustic sensors, Magnetic Sensors, Radiation detector (Gas-filled & Scintillation detectors), Chemical and Biosensors, Proximity sensor, Flow Sensor, Level Sensor.

Unit 3 **(8 Hours)**

Actuators: Definition, types and selection of Actuators; linear; rotary; Electrical actuators: Electric motors, DC servomotors, AC motors, Stepper motors, Solenoids, Hydraulic actuators - Control valves, Construction, Characteristics and Types - Directional Control valves, Pressure control valves, proportional control valves and Process control valves.

Unit 4 **(8 Hours)**

Micro Actuators: Actuation principle, Types of micro actuators- Electrostatic, Magnetic and Fluidic, Inverse piezo effect. Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials. Processing techniques: Vacuum deposition, sputtering, chemical vapor deposition and photolithography.

Practical component (if any) - Sensors and Actuators Lab – 60 Hours

1. Measurement of strain using strain gauge/load cells.
2. Measuring change in resistance using LDR
3. Measurement of displacement using LVDT.
4. Measurement using capacitive transducer.
5. Measurement of Temperature using Temperature Sensors.
6. Measurement of flow rate using electromagnetic flow meter.
7. Measurement of flow rate measurement using orifice plate flow meter.
8. System identification of any one of the actuators

(a) Electrical Actuator
(b) Electromechanical Actuator
(c) Electromagnetic Actuator
(d) Hydraulic and Pneumatic Actuator

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than ten.

Essential/recommended readings

1. Nakra& Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 2nd edition.
2. A.K. Sawhney, Electrical & Electronic Measurements & Instrumentation, 19th revised edition.
3. H.S Kalsi, Electronic Instrumentation, McGraw Hill, 4th edition.
4. DVS Murthy, Measurement & Instrumentation, PHI, 2nd edition.
5. D. Patranabis, Sensors and Transducers, PHI, 2nd edition.
6. A Course in Electrical and Electronic Measurements and Instrumentation, (2005), A.K. Sawhney, Dhanpat Rai& Co.
7. Mechanical and Industrial Measurements, 3rd Edition, Tenth Edition (1996), R.K. Jain, Khanna Publishers.
8. Andrzej M. Pawlak, "Sensors and Actuators in Mechatronics, Design and Applications", Taylor & Francis Group, 2006.
9. Andrew Parr, "Hydraulics and Pneumatics", Jaico Publishing House, Mumbai
10. Robert H. Bishop, "Mechatronic systems, Sensors and Actuators Fundamentals and Modeling, Taylor & Francis Group, 2007.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Electronic Instrumentation

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Electronic Instrumentation INDSC2C	4	3	0	1	Class XII pass with Science	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- To study different AC and DC measurement instruments used in laboratory like ohmmeter, voltmeter, ammeter and multimeter
- To learn about different measuring instruments–Universal counter, Cathode Ray Oscilloscope and Signal Generator
- To study about different spectrum analyzers and learn about basic concept of wave analyzers

Learning outcomes

The Learning Outcomes of this course are as follows:

Designing of different AC and DC bridges and their applications
Construction of different measuring devices-Ammeter, Voltmeter, Ohmmeter and Digital Frequency Meter
Develop an understanding of construction and working of different measuring instruments-Signal Generators and CRO for appropriate measurement
Understand the concepts of Spectrum Analyzer and Wave analyzers

SYLLABUS OF DSC-6

Unit-1 **(12 Hours)**

DC and AC Bridges based measurements: Wheatstone bridge, Kelvin bridge, General form of AC bridge balance, comparison bridges, Maxwell's bridge, Hay bridge, Schering bridge, Wien bridge, Wagner ground connection

DC and AC indicating instruments: DC voltmeter, ammeter, ohmmeters, multimeter,

AC voltmeter, Digital type voltmeters

Unit-2 **(12 Hours)**

Digital frequency meter: Elements of frequency meter, Universal counter and its different measurement modes, measurement errors and frequency range extension

Signal Generators: Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators, Random noise generator, Sweep generator

Unit-3 **(12 Hours)**

Electronic Displays: Block diagram of a General-Purpose Cathode Ray Oscilloscope and its basic operation, electrostatic focusing and deflection, screens for CRT and graticules, CRT Connections

Types of CROs and measurement of frequency and phase: Dual trace oscilloscope, Digital storage oscilloscope (DSO), Sampling oscilloscope, Lissajous figures

Unit-4 **(09 Hours)**

Spectrum and Wave Analyzers: Spectrum analyzer, Harmonic distortion analyzer, Wave analyzer **Q- Measurement:** Q-meter connections for low and high impedance measurements and errors

Practical component (if any) - Electronic Instrumentation Lab – 30 Hours

1. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO
2. Study the generation of Lissajous figures to find unknown frequency and phase shift
3. Measurements of Resistance Using Wheatstone/Kelvin Bridge
4. Measurements of Inductance Using Maxwell's Bridge/Inductance Comparison Bridge
5. Measurements of capacitance Using Capacitance Comparison Bridge/De Sauty's Bridge
6. Frequency measurement using Wein's Bridge
7. Study of R, L, C and Q meter
8. Study of Universal Counter
9. To study Loop tests for ground faults
10. To generate different signal waveforms

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than seven.

Essential/recommended readings

1. H.S. Kalsi, Electronic Instrumentation and Measurements, Tata McGraw Hill (2019), 4th edition.

2. Joseph J Carr, Elements of electronic instrumentation and measurement, Pearson Education
3. (2005).
4. C.S. Rangan, G.R. Sarma and V.S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill(1998).
5. H. Cooper, Modern electronic instrumentation and measurement techniques, Pearson Education (2015).
6. R.A. Witte, Electronic test instruments: Analog and digital measurements, Tata Mc Graw Hill (2004).
7. S. Wolf and R.F.M. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Pearson Education (2004).
8. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall of India, 2nd edition
9. U.A. Bakshi and A.V. Bakshi, Electronic Measurements and Instrumentation, Technical Publications

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.