Appendix-62
Resolution No. 38 {38-1 [38-1-5(3)]}

INDEX

DEPARTMENT OF ELECTRONIC SCIENCE

SEMESTER-II

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BSc. (Hons.) Electronic Science

Category I

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : Basic Instrumentation and Measurement Techniques

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		
Basic Instrumentation and Measurement Techniques ELDSC-4	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:
The objective of this subject is to provide insight into electronic instruments being used in the industries and labs. It details the basic working and use of different instruments used for measuring various physical quantities. Also, it details the identification, classification, construction, working principle and applications of various transducers used for displacement, temperature, pressure and intensity measurement.

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Describe the working principle of different measuring instruments.

CO2 Choose appropriate measuring instruments for measuring various parameters in their

CO3 laboratory courses.
Understand the significance of different measuring instruments including oscilloscopes.

SYLLABUS OF DSC-4

UNIT – I Fundamentals of Electronic Measurements (4 Weeks)

Qualities of Measurement: SI system of units. Specifications of instruments, their static and dynamic characteristics. Error (Gross error, systematic error, absolute error and relative error) and uncertainty analysis.

Basic Measurement Instruments: PMMC instrument, galvanometer, DC measurement - ammeter, voltmeter, ohm meter, AC measurement (rectifier type, electro dynamo meter), Watt meter. Digital voltmeter systems (integrating and non-integrating types), digital multimeter,

Connectors and Probes: low capacitance probes, high voltage probes, current probes, identifying electronic connectors – audio and video, RF/Coaxial, USB etc.

UNIT – II Impedance Measurement and Power Supplies (4 Weeks)

Measurement of Resistance and Impedance: Low Resistance: Kelvin's bridge method, Medium Resistance by Wheatstone bridge method, High Resistance by Megger. A.C. bridges, Measurement of Self Inductance, Anderson's bridge, Measurement of Capacitance, De Sauty's bridge, Measurement of frequency, Wien's bridge.

Regulated Power Supplies: Power Supply characteristics, Fixed power supply (78XX based), Dual power supplies (78XX and 79XX based), Variable power supply (LM317 based), current limiting, short-circuit shut down. Introduction of switch mode power supply (SMPS)

UNIT – III Oscilloscopes and Signal Generators (4 Weeks)

Electronic Displays: The Cathode Ray Oscilloscope (CRO): Block diagram of a General Purpose Oscilloscope and its basic operation. Measurement of voltage, frequency and phase by oscilloscope. Oscilloscope probes. Sampling Oscilloscope. Digital storage oscilloscope (DSO), advantages and applications, Oscilloscope specifications (bandwidth, sensitivity, rise time).

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

UNIT – IV Transducers and Sensors (3 Weeks)

Transducers and sensors: Classification of transducers, Basic requirement/characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge – Theory, types, temperature compensation and applications), Capacitive (Variable Area, air gap and permittivity Type), Inductive (LVDT) and piezoelectric transducers. Measurement of displacement, Measurement of temperature (RTD, thermistor, thermocouple, semiconductor IC sensors), Light transducers (photoresistors, photovoltaic cells, photodiodes).

Practical component (if any) – Basic Instrumentation and Measurement Techniques Lab

Learning outcomes

CO1 Perform experiments on the measuring instruments.

CO2 Perform measurements of various electrical/electronic parameters using appropriate instruments available in the laboratory.

CO3 Prepare the technical report on the experiments carried.

1. Design of ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge.
3. Measurement of Capacitance by De Sauty's bridge.
4. Measurement of Inductance by Anderson's bridge.
5. To determine the characteristics of resistance transducer - Strain Gauge.
6. To determine the characteristics of an LVDT.
7. To study the variations of thermo-emf of a thermocouple. (Type J/Type K)
8. To study the I-V characteristics of Solar Cell.
9. To study the Characteristics of LDR, Photodiode
   (i) Variable Illumination (ii) Linear Displacement.
10. Characteristics of one Solid State sensor/ Fiber optic sensor.

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.

Essential/recommended readings

1. H. S. Kalsi, Electronic Instrumentation, 3rd Edition, Tata Mcgraw Hill, (2006).
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
3. Joseph J Carr, Elements of Electronic Instrumentation and Measurement, 3rd Edition, Pearson Education (2005).
4. David A. Bell, Electronic Instrumentation and Measurements, 3rd Edition, Oxford University Press (2013).
5. R. A. Witte, Electronic Test Instruments, Analog and Digital Measurements, 2nd Edition, Pearson Education (2004).
6. A. K. Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpatrai and Sons (2007).
   K. Lal Kishore, Electronic Measurements and Instrumentation, 1st edition, Pearson Education India (2009).

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): Digital Electronics

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		
Digital Electronics ELDSC-5	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To represent information in various number systems.
- To convert data from one number system to another and do various arithmetic operations.
- To analyze logic systems and to implement optimized combinational circuits using Karnaugh Map.
- To analyze and implement sequential circuits using state machines.
- To analyze various memories and programmable logic devices.
- To analyze and understand the working of data converters.

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Understand the concept of the number system with emphasis on binary numbers, its algebra and minimization techniques.

CO2 Understand basic logic gates, concepts of Boolean algebra and techniques to reduce/simplify Boolean expressions.

CO3 Analyze and design combinational as well as sequential circuits.

CO4 Understand the concepts related to Memories and PLD's.

Understand the working of analog to digital converters, digital to analog converters.

SYLLABUS OF DSC- 5

UNIT – I Introduction to Digital Electronics (3 Weeks)

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, Octal and Hexadecimal arithmetic, Addition, subtraction by Complements (1's and 2's) method, Binary Multiplication by computer method, Signed numbers, Binary Codes (BCD, 84-2-1, excess-3, Gray) BCD addition, Error detecting/correcting code (Parity, Hamming).

Logic Gates and Boolean Algebra: Truth table and symbolic representation of logic gates and their implementation using Universal gates, Basic postulates and fundamental theorems of Boolean algebra.

UNIT – II Combinational Circuit Design (4 Weeks)

Canonical and Standard forms, Standard representation of logic functions (SOP and POS), Simplification of Boolean functions (up to 5 variables) using (i) Kmap (ii) Tabulation method, Binary Adder, Binary subtractor, parallel adder/subtractor, BCD adder, Code convertors.

Encoder, Decoder, Multiplexer, Demultiplexer, Implementing logic functions with Decoder and multiplexer.

UNIT – III Sequential Circuits (4 Weeks)

Sequential logic design: Latches and Flip flops, S-R, D, J-K, master slave, T Flip flops and their characteristic equation, Clocked and edge triggered Flip flops, conversion between flip flops, Shift Registers, Universal Shift register, Bidirectional Shift Register, Ring counter and Johnson counter, Counters (synchronous, asynchronous and modulo-N) and their timing sequence.

Synchronous Sequential circuit synthesis: State Tables, State Transition Diagrams, minimization, state assignments, realization with T, D and JK flip flops, Finite state machine- Mealy and Moore model

UNIT – IV Signal Conversion, Memories and Logic Families (4 Weeks)

A-D and D-A Conversion: 4 bit binary weighted resistor type D-A conversion, circuit and working. Circuit of R-2R ladder. A-D conversion characteristics, successive approximation ADC. (Mention of relevant ICs for all).

Memories: ROM, PROM, EPROM, EEPROM, Bipolar RAM, static and dynamic RAM, Memory Expansion (Word size and Word Capacity).

Programmable Logic Devices: Combinational circuit Implementation using PROM, PLA and PAL.

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

Practical component (if any) - Digital Electronics Lab *(Hardware and Circuit Simulation Software)*

Learning outcomes

CO1 Design simple digital systems.

CO2 Familiarize with Simulation and Synthesis Tools, Test Benches used in Digital system design.

CO3 Prepare the technical report on the experiments carried.

1. To verify and design AND, OR, NOT, XOR and XNOR gates using NAND gates.
2. To convert a Boolean expression into a logic gate circuit and assemble it using logic gate IC's.

3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.
6. Implement a Boolean function using 4 X 1 multiplexer.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type, JK, JK Master slave).
8. Design a SISO, SIPO shift register.
9. Design an asynchronous/ synchronous Up/Down counter using D/T/JK Flip-Flop.
10. Design a non sequential counter using D/T/JK Flip flop.
11. Design a R-2R DAC.
12. Design an ADC circuit using ADC0804.

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. M. Morris Mano, "Digital System Design," Pearson Education Asia.
2. Thomas L., "Flyod, Digital Fundamentals," Pearson Education Asia.
3. W. H. Gothmann, "Digital Electronics: An Introduction To Theory And Practice," Prentice Hall of India.
4. Millman & Grabel, "Microelectronics," Tata McGraw Hill.
5. Donald D. Givone, " Digital Principles and Design," Tata McGraw- Hill.
6. R. P. Jain, "Modern digital Electronics," Tata McGraw- Hill.

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Analog Electronics-I

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		
Analog Electronics-I ELDSC-6	**4**	**3**	**0**	**1**	**Course Admission Eligibility**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- Understand diodes (pn diode and Zener diode) and its applications in clipping and clamping circuits, rectifiers and voltage regulation (using Zener diodes) and concept of Power Supply.
- Understand frequency response of BJT and MOSFET amplifiers.
- Understand the concept of feedback and design feedback amplifiers and oscillators.
- Understand different power amplifiers and single tuned amplifiers.

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Illustrate about rectifiers, transistor and MOSFET amplifiers and its biasing. Also compare the performances of its low frequency models.
CO2 Describe the frequency response of MOSFET and BJT amplifiers.
CO3 Explain the concepts of feedback and construct feedback amplifiers and oscillators.
CO4 Summarizes the performance parameters of amplifiers with and without feedback

SYLLABUS OF DSC-6

UNIT – I Diode applications (3 Weeks)

Diode Circuits: Ideal diode, piecewise linear equivalent circuit, dc load line, static and dynamic resistance, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms, ripple factor & efficiency, Voltage doubler

Filters: Circuit diagram and explanation of shunt capacitor filter with waveforms.

Voltage Regulator: Zener diode regulator circuit diagram and explanation for load and line regulation

UNIT – II BJT based Amplifiers and Oscillator (4 Weeks)

Transistor: Input and Output Characteristics, Concept of Biasing and its significance, Concept of DC and AC analysis. Overview of Common Emitter BJT amplifier, Concept of Darlington pair

Power Amplifiers: Difference between voltage and power amplifier, classification of power amplifiers (Class A, Class B, Class AB, Class C, Class D), Concept of Class A single ended power amplifier, Transformer coupled Class A power amplifier and complementary symmetry Class B push pull power amplifier, overall efficiency, concept of crossover distortion, harmonic distortion and heat sinks.

Feedback Amplifiers: Concept of feedback, negative and positive feedback, voltage (series and shunt), feedback amplifiers gain, input and output impedances. Barkhausen criterion for oscillations, RC phase shift oscillator

UNIT – III MOSFET Fundamentals (4 Weeks)

MOSFET: Operation of n-channel and p-channel MOSFETs, Overview of Depletion and Enhancement MOSFET, Transfer Characteristics, Drain Characteristics, MOSFET as a switch. short channel effects, non-ideal effects in MOS transistors: the finite output resistance in the saturation region, the body effect, subthreshold conduction, breakdown effects, and temperature effects.

MOSFET DC analysis: Biasing circuits- drain feedback, voltage divider, source feedback, bias stability, Graphical analysis, load line.

UNIT – IV MOSFET based Amplifiers (4 Weeks)

MOSFET AC analysis: AC equivalent circuit of MOSFET, MOSFET parameters,

MOSFET Amplifiers: circuit and small signal model of Common Source amplifier, small signal parameters: input resistance, output resistance and voltage gain, circuits of Common Drain and Common Gate configurations. Comparison of BJT based (CE, CB and CC) and MOSFET based (CS, CD, CG) - Qualitative only.

Multistage MOSFET circuits: Cascaded circuits and Cascode circuits, effect of multistage circuits on gain and bandwidth.

MOSFET Application circuits: CMOS as inverter circuit, depletion mode n-MOSFET and p-MOSFET as load device

Practical component (if any) - Analog Electronics-I Lab

(Hardware and Circuit Simulation Software)

Learning outcomes

CO1 Study various stages of a zener diode based regulated power supply.
CO2 Understand various biasing concepts, BJT and FET based amplifiers.
CO3 Understand the concept of various BJT based power amplifiers and Oscillators.

1. Study of the half wave or full wave rectifier
2. Study of Zener diode as voltage regulator.
3. Study of any two types of
   (a) clipping circuits
   (b) clamping circuits.
4. Study of a Single Stage CE amplifier.
5. Study of Class A or Class B Power Amplifiers.
6. Study of Voltage divider bias for MOSFET
7. Study of the frequency response of Common Source MOSFET amplifier.
8. Study of MOSFET based Phase Shift Oscillator

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. Electronic Devices and circuit theory, Robert Boylestad and Louis Nashelsky, 9th Edition, 2013, PHI
2. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)
3. Electronic devices, David A Bell, Reston Publishing Company
4. Giovanni Saggio, Principles of Analog Electronics, CRC Press (2014)
5. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
6. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill (2001)
7. J. J. Cathey, 2000 Solved Problems in Electronics, Schaum‘s outline Series, Tata McGraw

BSc. (Hons.) Instrumentation

Category I

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 **INDSC2A**	4	3	0	1	Course Admission Eligibility	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

CO1 Learn various number systems, binary codes and concepts of Boolean algebra.

CO2 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.

CO3 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.

CO4 Compare various digital logic families with respect to their speed, power consumption and cost

SYLLABUS OF DSC-4

Unit-1 **(10 Lectures)**

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 Lectures)**

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 Lectures)**

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.

U**nit-4** **(14 Lectures)**

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

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.

Credit distribution, Eligibility and Prerequisites of the Course

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

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 INDSC2B	**4**	**2**	**0**	**2**	**Course Admission Eligibility**	**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

The Learning Outcomes of this course are as follows:

CO1 Identify and comprehend various sensors used in the real-life applications and paraphrase their importance
CO2 Classify and explain with examples of transducers, including those for measurement of temperature, strain, light, capacitance and inductance
CO3 Be conversant in construction and working of various pressure and flow measurement devices used for industrial purposes
CO4 Classify and explain the different types of actuators
CO5 To study various processing techniques of micro actuators

SYLLABUS OF DSC- 5

Unit 1 **(08 Lectures)**

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 **(08 Lectures)**

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 **(08 Lectures)**

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 **(08 Lectures)**

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

Learning outcomes

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

CO1 Identify different types of transducers

CO2 Understand the principles of the conversion of measured quantities into electric signal

CO3 Interpret the output and its relation with the input

CO4 Understand the sensing mechanisms to detect the various industrial parameters

C05 Measure and control industrial oriented parameters based on pressure, flow and temperature

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.

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**	**Course Admission Eligibility**	**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:

CO1 Designing of different AC and DC bridges and their applications
CO2 Construction of different measuring devices-Ammeter, Voltmeter, Ohmmeter and Digital Frequency Meter
CO3 Develop an understanding of construction and working of different measuring instruments-Signal Generators and CRO for appropriate measurement
CO4 Understand the concepts of Spectrum Analyzer and Wave analyzers

SYLLABUS OF DSC-6

Unit-1 (13 Lectures)

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 (11 Lectures)

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 (13 Lectures)

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 (11 Lecture

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

Learning outcomes

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

CO1 Practice the construction of testing and measuring setup for electronic systems.

CO2 Deep understanding about different instrumentation devices

CO3 Develop an ability to use measuring instruments and AC and DC bridges for measurements

CO4 Develop an ability to use digital oscilloscopes and waveform generators in laboratory

9. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO
10. Study the generation of Lissajous figures to find unknown frequency and phase shift
11. Measurements of Resistance Using Wheatstone/Kelvin Bridge
12. Measurements of Inductance Using Maxwell's Bridge/Inductance Comparison Bridge
13. Measurements of capacitance Using Capacitance Comparison Bridge/De Sauty's Bridge
14. Frequency measurement using Wein's Bridge
15. Study of R, L, C and Q meter
16. Study of Universal Counter
17. To study Loop tests for ground faults
18. 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

Pool of Generic Electives offered by Department of Electronic Science
Category-IV

GENERIC ELECTIVES (GE-2A): Digital System Design

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	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Digital System Design ELGE-2A	4	3	0	1	None	None	Electronic Science

Learning Objectives

In addition to familiarization with the combinational and sequential circuits, students will be adept in using simulation of digital circuits on software, which is in high demand, for designing combinational or sequential circuits. As there are lot of industrial and research-based job opening in the area, the course offers a hands-on in designing digital systems on hardware and testing with a holistic approach to the subject, making students ready for the industry or research

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Understand and represent numbers in powers of base and concepts of Boolean algebra.
CO2 Understand basic logic gates and minimization techniques.
CO3 Analyze and design combinatorial circuits.
CO4 Analyze and design sequential circuits.

SYLLABUS OF GE-2A

UNIT – I Number Systems and Boolean Algebra (3 Weeks)

Number System and Boolean algebra: Decimal, Binary, Hexadecimal, Octal, BCD, Conversions, Complements (1's and 2's), Signed and unsigned numbers, addition and

subtraction, Gray Code. Boolean algebra- Positive and negative logic. Boolean laws, De Morgan's theorems, simplification of Boolean expressions-SOP and POS

UNIT – II Logic Gates and Minimization (4 Weeks)

Logic gates and Karnaugh map: Logic gates- basic logic gates-AND, OR, NOT, logic symbol and truth table. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. K-map minimization of 3 and 4 variable functions/expressions.

UNIT – III Combinational Circuits (4 Weeks)

Combinational logic analysis and design: Multiplexers and Demultiplexers, Adder (half and full), Subtractor (half and full), Parallel adder/subtractor, Encoder and Decoder, Understanding VHDL program of a Full Adder and 3 to 8 decoder

UNIT – IV Flip Flops and Counters (4 Weeks)

Sequential logic design: Latch, Flip flop, S-R FF , J-K FF, T and D type FFs, clocked FFs, registers, Counters (synchronous and asynchronous, ring and Johnson)

Practical component (if any) - Digital System Design Lab

(Hardware and Circuit Simulation Software)

Learning outcomes

CO1 Familiarize with combinational circuit design.
CO2 Familiarize with sequential circuit design.
CO3 Familiarize with circuit Simulation software.

To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. Design a Half and Full Adder.
3. Design a Half and Full Subtractor.
4. Implement Boolean functions using 8X1 and 16X1 Multiplexers.
5. Implement Boolean functions using decoder.
6. Implement an encoder.
7. Study of counters using dedicated counter ICs.
8. Study of registers (SISO, SIPO, PISO and PIPO) using universal shift register IC.

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. M. Morris Mano Digital System Design,Pearson Education Asia,(Fourth Edition)
2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)

3. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
4. R. L. Tokheim, Digital Principles, Schaum_s Outline Series, Tata McGraw- Hill (1994)

GENERIC ELECTIVES (GE-2B): Data Visualization Techniques

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
		Lecture	Tutorial	Practical/ Practice		
Data Visualization Techniques ELGE-2B	4	3	0	1	None	Basic Knowledge of Python Programming Language

Learning Objectives

This course is all about data visualization, the art and science of turning data into readable graphics. It enables the students to design and create data visualizations based on data available and tasks to be achieved. This process includes data modeling, data processing (such as aggregation and filtering), mapping data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception as well as the task(s) at hand. Students will also learn to evaluate the effectiveness of visualization designs, and think critically about each design decision, such as choice of color and choice of visual encoding. Students will create their own data visualizations, and learn to use Open-Source data visualization tools.

Learning outcomes

The Learning Outcomes of this course are as follows:
CO1: Design and create data visualizations.
CO2: Conduct exploratory data analysis using visualization.
CO3: Craft visual presentations of data for effective communication.
CO4: Use knowledge of perception and cognition to evaluate visualization design alternatives.
CO5: Design and evaluate color palettes for visualization based on principles of perception.
CO6: Apply data transformations such as aggregation and filtering for visualization.
CO7: Identify opportunities for application of data visualization in various domains.

Tools Required: Open-source Visualization tools, Python, Plotly, Tableau

SYLLABUS OF GE-2B

UNIT – I Understanding Data Visualization (3 Weeks)

Introduction to Data Visualization, Various tools for Data Visualization. Introduction to Numpy, Pandas and Matplotlib. Structured & Semi-structured Dataset, Data Cleaning and Preparation. Handling Missing Data, Data Transformation. Basic Plotting with Matplotlib, Dataset on Immigration e.g. Canada (source: https://open.canada.ca)/ any other. Univariate and Multivariate Visualization. Introduction to cloud computing.

UNIT – II Data Visualization Techniques (4 Weeks)

Data Visualizations Techniques: Line Plots, Area Plots, Histograms, Bar Charts, Pie Charts, Box Plots, Scatter Plots, Bubble Plots, Waffle Charts, Word Clouds, Seaborn and Regression Plots, Creating Maps and Visualizing Geospatial Data **-** Introduction to Folium, Maps with Markers, Choropleth Maps.

UNIT – III Creating Dashboards with Plotly (4 Weeks)

Introduction to Seaborn, Basic plotting with Seaborn. Introduction to Plotly. Scatter chart, Bubble Plot, Pie chart, Gantt chart, Contour plotting, Sunburst and Polar charts, Heatmaps.

UNIT – IV Data Visualization using Tableau (4 Weeks)

Introduction to Tableau Desktop, connecting to dataset, Data preparation, Filtering and sorting data, Creating basic chart types (bar charts, line charts etc.), Assembling a dashboard layout, Using dashboard filters, Transform the data, Simple calculations in Tableau, Creating advanced chart types. Introduction to Data Story.

Practical component (if any) - Data Visualization Techniques Lab

Learning outcomes

CO1: Implement various data visualization techniques using Python and Tableau.
CO2: Implement basics of cloud computing.
CO3: Implement data transformations such as aggregation and filtering for visualization.

(Perform practical on Dataset available at Kaggle / Github / UCI Machine Learning Repository)

1. Visualization of Spreadsheet Models.
2. Visualization of Semi-Structured Data.
3. Interactive Plots in Python and Tableau.
4. Hierarchical and Topographical Data Visualizations in Tableau.
5. Calendar Heatmaps and Flow Data Visualizations in Python.
6. Time Series Data Visualization in Plotly.

7. Creating cloud account Amazon/Azure/Google/IBM to store images /files / programs.
8. Use a dataset that contains immigration details e.g. Canada for a given duration of 30 years (Canada Immigration Dataset, source: https://open.canada.ca) or any other
    a. Create an area plot for top 6 immigrant countries in a given duration.
    b. Create and year-wise immigrant bar chart from India to Canada in a given duration.
    c. Create a boxplot of immigrants for three given countries.
    d. Show the total no. of immigrants using Area Chart and Pie chart for two given countries.
    e. Create a scatter Histogram for the immigrants in the given year for two specific countries.

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. Data Visualization with Python for Beginners: Visualize Your Data using Pandas, Matplotlib and Seaborn by AI Publishing. ISBN: 1733042680-978
2. Learn and Practice Data Visualization using Python by Swapnil Saurav, Eka Publishers. ISBN: 8194633426-978
3. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: 9352134915-978
4. Data Visualization with Tableau by Praveen Kumar, Gurucool Publishing. ISBN: 8194746997-978
5. Interactive Dashboards and Data Apps with Plotly and Dash by Elias Dabbas, Packt Publishing Limited. ISBN: 1800568914-978

Suggestive readings -

1. Python Data Science Handbook by Jake VanderPlas, Shroff/O'Reilly. ISBN: 9352134915-978
2. Data Science from Scratch: First Principles with Python by Joel Grus, Shroff/O'Reilly. ISBN: 9352138326-978

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

Pool of Generic Electives (GE) offered by Department of Electronic Sciences in Instrumentation

Category-IV

GENERIC ELECTIVES (GE-2A): MATLAB and its Applications

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	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
MATLAB and its Applications INGE2A	**4**	**2**	**0**	**2**	**None**	**None**	**Electronic Science**

Learning Objectives

- To learn to interact and perform the computations on MATLAB
- To plot the functions using various types of plot command
- To understand the difference between the functions & Scripts in MATLAB
- To familiarize with the fundamentals of digital image and signal processing

Learning outcomes

The Learning Outcomes of this course are as follows:

CO1 Interact with MATLAB for various computations
CO2 Generate plots and its use in reports
CO3 Familiar with inbuilt MATLAB functions and will be able to create user defined Functions and write scripts for various applications
CO4 Understands fundamental of digital image and signal processing

SYLLABUS OF GE-2A

Unit-1 **(06 Lectures)**

Introduction to MATLAB: MATLAB features, MATLAB Windows, defining variables, formatting output, types of operators, different operations on variables, checking existence, clear
Operations, data type, precedence.

Unit-2 **(10 Lectures)**

Introduction to Arrays: Defining scalars, vectors, matrix, multi-dimensional arrays, different Operations (mathematical, logical, and relational) on array, reshaping matrices, importing & exporting of data.

Character and Strings: Defining character and string, accessing character or substring from string, string concatenation and comparing, conversion between strings and number. Defining and working with cell arrays.

Data Plotting: Graph, plot, types of plot, multiple plots, labeling graph, line colors, style and Marker.

Unit-3 **(08 Lectures)**

Script and Function M File: M-file, writing script files, writing functions, error correction, saving files. Flow control statement: Conditional or selection, error handling, loop control, program termination.

Unit-4 **(08 Lectures)**

Signal Processing: Generation of continuous time & discrete time signal, time shift, time scaling, amplitude scaling of signal. Generation of amplitude modulated signal, frequency modulated signal Image processing: Study of basic tools of Image Processing, Image segmentation, restoration, histogram processing, changing color of image.

Practical component (if any) - MATLAB and its Applications Lab

Learning outcomes

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

CO1 Interact with MATLAB for understanding various tasks

CO2 Understand and design calculator by exploring and utilizing the power of MATLAB

CO3 Develop program for plagiarism check

CO4 Generate modulated signals and change the color of original image

CO5 Analyze and prepare the reports on the experiment carried out

1. Define variables, create a matrix of any size with all possible methods and perform various mathematical operations.
2. Create a multidimensional array and delete any Row/Column from it and create a new array.
3. Plot and label all the trigonometric functions using the subplot command.
4. Generate various kinds of continuous and discrete time signals. Plot them with different color, line style and markers and label the graph.
5. Generate various kinds of continuous and discrete time signals. Perform time scaling, time shifting and amplitude scaling on them.

6. Generate the (i) square wave and (ii) triangular wave of a specific amplitude and time period and plot it on a single graph.
7. Define a string and count the number of vowels, spaces and consonants in it. Also mention the size and length of the string.
8. Write a script to remove (i) all the alphabets from the alphanumeric string, (ii) all the spaces from a string.
9. Create a function which compares any two strings of equal length and return 'M' for matched character and 'U' for unmatched Character. Also display the number of characters matched.
10. Generate the (i) AP, (ii) GP and (iii) Fibonacci series.
11. Write a script to test whether a user defined no. is Prime or not.
12. Write a script which can evaluate the percentage (%) and grade of the student when subject marks are entered by the user.
13. Write a script to generate the amplitude and frequency modulated signal.
14. Create a function to change the colors of user defined images.

Essential/recommended readings

1. Khanna, M., Bhatt, G. and Kumar, P., MATLAB Essentials for Problem Solving, PHI Learning, New Delhi.
2. Mathews, J.H. and K.D. Fink, Numerical Methods Using MATLAB - Third Edition, Prentice Hall, Upper Saddle River, New Jersey.
3. Linfield, G. & Penny, J., Numerical methods using MATLAB, Ellis- Horwood.
4. Van Loan, C.F., Introduction to Scientific Computing - A Matrix-Vector Approach Using MATLAB, Prentice Hall, Upper Saddle River, New Jersey.
5. Nakamura, S., Numerical Analysis and Graphic Visualization with MATLAB - Second Edition, Prentice Hall PTR, Upper Saddle River, New Jersey

GENERIC ELECTIVES (GE-2B): Sensors and its Applications

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
		Lecture	Tutorial	Practical/ Practice		
Sensors and its Applications INGE2B	4	3	0	1	None	Nil

Learning Objectives

- To understand the operation of commonly used sensors and actuators.
- To be able to analyze and select most appropriate sensors or actuators for an

application.

- To analyze characteristics of sensors and actuators by knowing their basic laws and processes.

Learning outcomes

CO1 Identify and comprehend various sensors used in the real-life applications and paraphrase their importance.

CO2 Classify and explain with examples the utilization of sensors for measurement of temperature, strain, motion, position and light in the industry.

CO3 Understand the role of sensors and actuators to make sensitive measurements of physical parameters like pressure, flow, acceleration, velocity etc.

SYLLABUS OF GE-2B

Unit 1 **(12 Lectures)**

Mechanical and Electromechanical sensor: Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, Applications of electromechanical sensor: Human motion monitoring, Human health monitoring, Speech recognition, Human-machine interface

Unit 2 **(12 Lectures)**

Transducers: Classification, Active and Passive. Principle, working and applications of following types: Resistive (Strain Gauge): Theory, type, materials, design consideration, sensitivity, gauge factor, Capacitive, Inductive (LVDT), Piezoelectric, Light (LDR), Temperature (RTD, Thermocouple, Thermistor). Magneto strictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type.

Unit 3 **(12 Lectures)**

Flow meters, mechanical type: theory of variable head type flow meters-orifice plate, venturi tube, flow nozzle, Positive displacement flow meters. Rota meter: thermal mass flow meter, Principle and constructional details of electromagnetic flow meter, different types of ultrasonic flow meters.

Unit 4 **(12 Lectures)**

Tachometers: Mechanical, Electric, Contact less, Frequency, Stroboscopic tachometers, Manometers: different types – elastic type pressure gauges, Bourdon type bellows, diaphragms.

Practical component (if any) - Sensors and its Applications Lab

Learning outcomes

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

CO1 Explain fundamental physical and technical base of sensors and actuators

CO2 Describe basic laws and phenomena that define behavior of sensors and actuators

CO3 Analyze various approaches, procedures and results related to sensors and actuators

CO4 Conduct experiments and measurements in laboratory and on real components, sensors, and actuators

CO5 Interpret the acquired data and measured results

1. Measurement of pressure, strain and torque using strain gauge.
2. Measurement of displacement using LVDT.
3. Measurement using load cells.
4. Measurement using capacitive transducer.
5. Measurement using inductive transducer.
6. Measurement of temperature using Temperature Sensors.
7. Characteristics of Hall effect sensor.
8. Measuring change in resistance using LDR
9. Discharge coefficient of orifice plate.
10. Measurement of flow using E.M. flow meter.
11. Measurement of flow using Ultrasonic flow meter.

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. A.K Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai& Co, 12th edition, 2001.
2. R.K. Jain, Mechanical and Industrial Measurements, Tata McGraw Hill, New Delhi, 1996, 11th edition.
3. A.K. Sawhney, Electrical & Electronic Measurements & Instrumentation, 19th revised edition, 2012
4. Nakra& Choudhary, Instrumentation measurements and analysis, Tata McGraw Hill, 2nd edition, Revised 2016-2017

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