ST JOSEPH'S UNIVERSITY

BENGALURU-27

DEPARTMENT OF ELECTRONICS

Curriculum for B.Sc.

as per

SJU- 2024-2025

SYLLABUS FOR UNDERGRADUATE PROGRAMME

2024-2025 Onwards

Electronics Curriculum Structure

Semester	Title
	Major Discipline core
I Semester	DSC1: Electronic Devices and Circuits
II Semester	DSC2: Amplifiers, Oscillators, and OP-AMP
III Semester	DSC3: Digital Electronics
IV Semester	DSC4: Power Electronics
V Semester	DSC 5.1: Electronic Communication Systems
V Semester	DCS 5.2: Microprocessor 8086
V Semester	DSC 5.3: Data Acquisition System and Instrumentation
SKILL-1	PCB Design and Fabrication
VI Semester	DSC 6.1: Advanced Communication Systems
VI Semester	DSC 6.2: Microcontrollers and Embedded Systems
VI Semester	DSC 6.3: Introduction to IoT and Robotics
SKILL-2	System Verilog and FPGA

Semester- I

EL 124: Electronics Devices and Circuits

Unit 1 — 12 Hours

Electronic Components: Electronic passive and active components, types and their properties, Concept of Voltage and Current Sources, electric energy and power. (Qualitative only). Ohms law and Kirchhoff's law, Voltage Divider Rule and Current Divider Rule, Network Theorems: Superposition, Thevenin's, Norton's, Maximum Power Transfer, and Reciprocity Theorems. DC and AC analysis of RC and RL circuits, RLC series and parallel Resonant Circuits (no derivation).

Unit 2 — 12 Hours

PN junction diode: Ideal and practical diodes, Formation of Depletion Layer, Diode Equation and I-V characteristics. Idea of static and dynamic resistance, Zener diode, Reverse saturation current, Zener and avalanche breakdown. Rectifiers-Half-wave and Full wave (center tapped and bridge) rectifiers, expressions for output voltage, ripple factor, and efficiency (mention only), Shunt capacitor filter. (Numerical examples wherever applicable).

Voltage regulator: Block diagram of regulated power supply, Line and Load regulation, Zener diode as voltage regulator – circuit diagram, load and line regulation, disadvantages. Clippers (shunt type) and clampers (Qualitative analysis only), Voltage Multipliers.

Unit 3 — 8 Hours

Bipolar Junction Transistor: Construction, types, CE, CB and CC configurations (mention only), V-I characteristics of a transistor in CE mode, Regions of operation (active, cut off and saturation), leakage currents (mention only), Current gains α, β and their inter-relations, dc load line and Q point. Applications of transistor as amplifier and switch - circuit and working. (Numerical examples wherever applicable).

Unit 4 — 8 Hours

Transistor biasing: Thermal runaway, stability and stability factor, Stabilization circuits-Fixed Bias and Voltage Divider Bias. Amplifier: Small signal analysis of single stage CE amplifier using re' model. Input and Output impedances, Current and Voltage gains. CC amplifier as a buffer amplifier. (Numerical problems wherever applicable).

Self-study — 05 Hours

Special semiconductor diodes: Varactor diode, Schottky diode, Tunnel diode, - construction, characteristics, working, symbol, and applications for each. LED, LCD and solar cell – construction, operation and applications, 7-segment display, concept of common anode and common cathode types, optocouplers.

Text Books:

1. Robert L Boylestad, “Introductory circuit analysis”, 5th Ed.., Universal Book 2003.
2. R.S. Sedha, “A Textbook of Applied Electronics”, 7th Ed., S. Chand and Company Ltd. 2011
3. A.P. Malvino, “Principles of Electronics”, 7th Ed.TMH, 2011.

Reference Books:

4. David A. Bell “ Electronic Devices and Circuits”, 5th Ed., Oxford Uni. Press, 2015
5. M. Nahvi& J. Edminister, “Electrical Circuits”, Schaum’s Outline SeriesTMGH2005
6. S. A. Nasar,” Electrical Circuits”, Schaum’s outline series, Tata McGraw Hill, 2004
7. J. Millman and C. C. Halkias, “Integrated Electronics”, Tata McGraw-Hill, 2001
8. A.S. Sedra, K.C. Smith, A.N. Chandorkar “Microelectronic circuits”, 6th Edn., Oxford University Press, 2014
9. J. J. Cathey, “2000 Solved Problems in Electronics”, Schaum’s outline Series, TMG1991

Practical I

EL 1P1: Practical (11 sessions, 3 hours/week)

List of experiments

Study of resistance color code, test and measuring instruments, and Ohm’s Laws (1 practical class)

1. Charging and discharging of a capacitor
2. Superposition Theorem
3. Thevenin’s Theorem
4. Maximum Power Transfer Theorem
5. Semiconductor diode and Zener diode characteristics
6. *Half-wave rectifier*, and Center tap full-wave rectifier with & without a capacitor filter
7. Voltage quadrupler using diodes
8. Zener regulator- Line and Load regulation
9. Fixed bias circuit with emitter resistor
10. Voltage divider bias circuit
11. CE amplifier- Frequency response

Semester- II

EL 224: Amplifiers, Oscillators, and Op-Amp.

UNIT 1: Amplifier 16 Hours

Multistage Amplifiers: Need & use of multistage amplifiers, overall gain, cascade Vs cascode. RC coupled amplifier. Darlington amplifier – circuit, current gain, Zi, Zo, advantages.

Power amplifiers: Voltage Vs Power amplifiers, need for power amplifiers, Classification Class A, Class C (mention only)

Class B: push-pull amplifier, working, efficiency (derivation), crossover distortion, harmonic distortion, complementary symmetry (transformerless). Comparison.

Tuned amplifiers: need for single tuned and double tuned, working, frequency response curve, advantages & disadvantages, note on coupling.

JFET–Types - p-channel and n-channel, working and I-V characteristics - n-channel JFET, parameters and their relationships, Comparison of BJT and JFET. Common Source Amplifier, MOSFET: E&D, MOSFET – n-channel and p-channel, Construction, working, symbols, biasing, drain and transfer characteristics, CMOS logic, CMOS inverter - circuit, working and characteristics.

UNIT 2: Feedback amplifiers and Oscillators 10 Hours

Feedback: Types of Feedback, Positive and Negative, Block Diagrams, Effect of Feedback on Av, BW, Zi, and Zo (only for Voltage Series Feedback Amplifier Circuit).

Need for oscillators: Positive feedback, Tank circuit – oscillations, resonant frequency. Barkhausen criterion for oscillation, LC tuned oscillator - Colpitts and Hartley's oscillator, frequency of oscillation (no derivation), minimum gain, advantages & disadvantages, RC Oscillators - phase shift & Wein bridge oscillator (no derivation), frequency and minimum gain, crystal oscillator, piezoelectric effect, equivalent circuit, series & parallel resonant circuits, Q factor.

Non-Sinusoidal oscillators: Astable Multivibrator, Working waveforms, frequency formula (mention only), Monostable multivibrator, bistable multivibrator (flip-flop concept).

UNIT 3: Integrated circuits 04 Hours

IC555 block diagram & pin diagram. IC555 Applications – Astable (derivation) and Monostable multivibrators, Voltage-controlled oscillator. Schmitt trigger. IC Regulators: LM317, IC78XX, 79XX series (block diagram)

UNIT 4: Op-Amp - Theory and Applications 11 Hours

Op-Amp block diagram, pin diagram IC741, specifications, characteristics of ideal and practical op amp parameters-input bias current, input offset voltage, output offset voltage, CMRR, slew rate SVRR, offset null, open loop Op-Amp limitations, Closed loop Op-Amp. Block Diagram of negative series feedback amplifier, Inverting and non-inverting feedback circuit, gain, R_{if}, R_{of}. Virtual ground, unity gain bandwidth product.

Applications: Adder - inverting and non-inverting, subtractor, scale changer, buffer, integrator, differentiator (ideal and practical). Comparator, zero crossing detector, Active filters - Butterworth

first order low pass, high pass, band pass, band stop, all pass filters. Second order Filters (mention only).

Self-study: 4 Hours

IC fabrication techniques.

Text Books

1. Operational amplifier and linear circuits, Ramakanth Gayakwad PHI, 5th Edition, 2015.
2. A Text Book of Applied Electronics, R.S. Sedha

Reference Books

3. Electronic Devices and circuits, T.F. Bogart and Beasley, Pearson Education, 6th Edition, 2004.
4. Electronics Principle-AP Malvino, Tata McGraw-Hill, 6th edition, 2005.
5. Electronic Devices and Circuits, T. L. Floyd, PHI, 5ht Edition 2005.
6. Microelectronics Circuits, Sedra and Smith, 5th Edition, Oxford University Press
7. Basic Electronics- A Text Lab Manual, Paul B Zbar, A.P. Malvino, TMH, 7th Edition,1995.

Practical II

EL2P1: PRACTICALS (11 sessions 4 hours/week)

List of experiments

1. Colpitts Oscillator
2. Construction of regulated power supply using IC 7805 and IC 7905
3. Op-amp Adder, subtractor and scale changer
4. Phase-shift oscillator using IC 741
5. Wien-Bridge oscillator using IC 741
6. Op-amp comparator
7. Hartley Oscillator
8. Astable multivibrator using transistors
9. Current and voltage regulation using IC LM 317
10. Op – amp as an inverting and non-inverting amplifier.
11. Astable multivibrator using IC555.
12. FET CS amplifier

Semester- III

EL 324: Digital Electronics

Unit1: Number System 03 Hours

Number System: Decimal, Binary, Octal, and Hexadecimal number systems, base conversions. Representation of signed and unsigned numbers, Binary arithmetic; addition, 1's complement, subtraction by 2's complement method, BCD code, Excess-3 and Gray code.

Unit2: Boolean Algebra 07 Hours

The Inverter, AND gate, OR gate, NAND gate, NOR gate, Exclusive-OR and Ex-NOR gate, Programmable Logic and Fixed-Function Logic gates. Boolean Algebra and Logic Simplification: Boolean Operations and Expressions, Laws and Rules of Boolean Algebra. De Morgan's Theorems. Boolean Analysis of Logic Circuits. Logic Simplification using Boolean Expressions.

Unit 3: Logic families & Pulse characteristics 10 Hours

Review of Logic gates. SOP, POS, and K-map (simplification), Logic families – classification of logic families. TTL NAND gate. TTL IC terminology (74HXX,74LXX) & characteristics. MOS logic, CMOS inverter. CMOS characteristics, interfacing CMOS to TTL & vice versa. Pulse characteristics: ideal & non-ideal pulses. Characteristics of pulses, rise time, fall time, and pulse duration in non-ideal pulses.

Unit 4: Combinational logic circuits 09 Hours

Half adder, half subtractor, full adder, full subtractor. Two-bit and 4-bit magnitude comparators, IC 7485- pin diagram, Multiplexers - 4:1, 8:1 and 16:1 Multiplexer, logic diagram and truth table of each, applications, Demultiplexers - 1:4, 1:8 and 1:16 & ICs associated with them. (74150/74154) Decoder – 7446/47 BCD to seven segment decoder/driver, Encoder, priority encoder, Decimal to BCD encoder-circuit & priority encoder IC. Logic diagram, explanation & truth table.

Unit 5: Sequential logic circuits 12 Hours

Latches & Flip-flops (NAND and NOR latches), Clock pulses, edge-triggered versus level-triggered. RS, D, JK. JK master slave, T flip flops. Circuits, working & truth table. Preset & clear functions in flip-flops, timing diagram. IC7476, IC7473.
Shift registers: SISO, SIPO, PISO & PIPO circuit, working, truth table, timing diagram. IC7476/73. Counters: Asynchronous counters; mod 4, mod 8, mod 16, Decade Counters, glitches, truncated counters like mod 3, 5. Asynchronous up – down counters. IC7490, mod 4, 8-decade counters, Synchronous counters (3-bit counter), Johnson & Ring counters.

Self-Study 04 Hours

Interfacing of TTL with sub-families, Realization of Multiplexers 32:1 using 16:1, Demultiplexers 1:32, mod 8,16-decade counter, error checking and correction codes (Only parity check).

Text Books:

1. Digital fundamentals: T.L.Floyd , Universal Book Stall,8th edition,2005.
2. Modern digital electronics R.P Jain –TMH publication, 3rd edition, 2003.
3. Verilog HDL: A Guide to Digital Design and Synthesis – Samir Palnitkar

Reference Books:

4. Fundamentals of digital circuits: A Anand Kumar, PHI, 3rd edition 2004
5. Experiments in Digital Electronics: Malvino and Leach – TMH, 2000
6. Digital Lab Primer- K A Krishnamurthy, Pearson education 2003

Practical III

EL 3P1: Digital Electronics Practical (11 sessions 4 hours/week)

List of experiments

1. Realization of Basic gates using diode and transistor
2. Realization of Basic gates using NAND gates using IC 7400
3. Realization of Basic gates using NOR gates using IC 7402
4. Half Adder and Half Subtractor using NAND gates
5. Full Adder using IC 7486 and IC 7400
6. Binary to Gray code and Gray code to Binary conversion
7. Clocked RS, D Flip-flops using NAND gates
8. 4 –bit binary ripple up counter using IC 7476/74107
9. Decade counter using IC 7490.
10. Study of De-Multiplexer using IC 74154
11. Study of Multiplexer using IC 74150

SEMESTER IV

EL424: Power Electronics

Unit- 1: Power diodes 08 Hours

Need for semiconductor power devices, Power diodes: Tunnel diode; V-I characteristics, parameters, equivalent circuit, applications. Varactor diode: specifications, applications. Schottky diode; construction, enhancement of reverse blocking capacity; Step Recovery Diode (SRD), harmonic generator. Optical disks, read-only optical disk equipment, printers using laser diodes, hologram sensors, laser range finders, optical isolators, optical modulators

Unit-2: Power Devices 15 Hours

Introduction to the family of Thyristors, classification of Thyristors. Unijunction transistor: basic construction, equivalent circuit, intrinsic stand-off ratio, UJT operation, characteristics. Programmable Unijunction Transistor, DIAC - V-I characteristics, Silicon Controlled switch, operation. Silicon- controlled rectifier (SCR) - Operation, biasing, equivalent circuit, turning ON SCR, turning OFF SCR, V-I characteristics, forward characteristics, reverse characteristics, ratings. TRIAC - operation, V-I characteristics, ratings, applications, difference between SCR and TRIAC.

Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations, safe operating area (SOA), etc. Power MOSFETs - Operation modes, switching characteristics, power BJT, second breakdown, saturation, and quasi-saturation state.

Unit -3: Applications of Thyristors 06 Hours

SCR as a static switch, phase-controlled rectification, single-phase half-wave, and full-wave. R and RC triggering of SCR, UJT Triggered SCR. An AC voltage controller using SCR and TRIAC as a switch.

Unit- 4: Power Inverters and Choppers 12 Hours

Power Inverters: Need for commutating circuits and their various types, DC link inverter, Parallel capacitor commutated inverters with and without reactive feedback and its analysis, Series Inverter - limitations and improved versions.

Choppers: basic chopper circuit, types of choppers (Type A-D), step-down chopper, step-up chopper, operation of DC chopper circuits using self-commutation (A & B-type commutating circuit), cathode pulse turn-off chopper (using class D commutation).

Self-Study 04 Hours

Electromechanical machines: basic structure of rotor, shaft, thyristor control of AC motor, Light-activated SCR (LASCR), Snubber Circuit

Text Books:

1. P. S. Bhimbra, *Power Electronics*.New Delhi, India: Khanna Publishers, latest ed.
2. M. H. Rashid, *Power Electronics: Circuits, Devices, and Applications*.Upper Saddle River, NJ, USA: Pearson Education, latest ed.

Reference Books:

3. Power Electronics, P.C. Sen, TMH
4. Power Electronics & Controls, S.K. Dutta
5. Power Electronics, M.D. Singh & K.B. Khanchandani, TMH
6. Power Electronics Circuits, Devices and Applications, 3rd Edition, M.H. Rashid, Pearson Education
7. Power Electronics, Applications and Design, Ned Mohan, Tore.
8. Power Electronics, K. HariBabu, Scitech Publication.
9. Power Electronics, M.S. Jamil Asghar, PHI.

Practical-IV

EL4P1: Practical (11 sessions - 4 hours / week)

List of Experiments:

1. V-I Characteristics of UJT
2. UJT as a relaxation oscillator
3. Study of I-V characteristics of DIAC
4. V-I Characteristics of **SCR** and determination of firing angle
5. R triggering of SCR.
6. SCR Half-wave rectifier using RC triggering
7. Study of I-V characteristics of a TRIAC
8. V-I Characteristics of MOSFET
9. V-I Characteristic of IGBT
10. Design of Snubber Circuit
11. Study of Chopper circuits

SEMESTER V

EL5125: Electronic Communication Systems

Unit 1 Noise and Transmission lines 08 Hours

Noise-Introduction, internal and external noise, signal-to-noise ratio, and noise figure numerical examples. Transmission lines - types and equivalent circuit of T-lines, primary and secondary constants. reflection coefficient, VSWR, and CSWR, numerical examples, losses, and distortions in T lines. Propagation of waves: ground wave, sky wave, and space wave propagation; the ionosphere and its effects.

Unit 2 Antennas 10 Hours

Antenna Parameters: Definitions and formulas: Gain, directivity, beamwidth, bandwidth, polarization, power gain, radiation, radiation resistance. Equivalent circuit of an antenna, wire antennas, resonant and non-resonant antennas. Radiation Patterns: Current distribution for different lengths (λ/2, λ, 3λ/2). Dipole antenna, Power Radiation: Derivation of Total Power and Radiation Resistance. Other Types: Grounded and ungrounded antennas. Microstrip antenna (Mention only).

Unit 3 Analog Modulation techniques 12 Hours

Block diagram of an electronic communication system. modulation-need and types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBSC, SSB, SSBSC and VSBS (mention only), AM collector modulator. Limitations of AM. FM - definition, modulation index, FM frequency spectrum, bandwidth requirements, frequency deviation, and carrier swing, FM generator-varactor diode modulator. Block diagram of AM transmitter and FM transmitter with AFC, qualitative study of pre-emphasis and de-emphasis. Comparison of AM and FM, numerical examples.

Unit 4 Radio Receivers 10 Hours

Demodulation- AM detection – principles of detection, linear diode and Transistor detector circuits, principle of working, and waveforms. FM detector – principle, slope detector circuit, working. AM superheterodyne receiver– principle, block diagram, function of each stage with waveform, qualitative study of AGC. FM superheterodyne receiver– principle, block diagram, function of each stage with waveform. Characteristics of radio receivers: qualitative study of sensitivity, selectivity, signal-to-noise ratio, fidelity, stability, image frequency, and its rejection.

Self-Study 5 Hours

Modems - Classifications, modes of modem operation, AM Demodulation and FM Demodulation - Phase Discriminator, FET reactance modulator, Radiography testing, Antenna design using HFSS tools.

Text Books:

1. Electronic Communication, Dennis Roddy &John Coolen –IV edition-PHI, 2005
2. Electronic Communication systems, Kennedy &Davis IV, the edition, 2005, TATA McGraw-Hill

3. Electronic Communication Systems, Wayne Tomas –5th edition –Pearson Education, 2005

Reference Books:

1. Handbook of experiments in electronics and communication-Poorna Chandra Rao & Sasikala, VIKAS Publishing house, 2004
2. Basic Electronics -A text lab manual, -Paul B. Zbar, Albert P. Malvino & Michael A. Miller, Tata McGraw-Hill, 1997.
3. Communication Electronics, Frenzel, TMH, 3rd Edition, 1999.

Practical V-Paper 1

EL5P1: Practical (11 sessions, 3 hours/week)

List of Experiments:

1. Voltage-controlled oscillator using IC 555
2. Schmitt Trigger using IC 555
3. Amplitude modulator and demodulator
4. Frequency modulator
5. Pre-emphasis and de-emphasis circuits.
6. Frequency Multiplier using transistors
7. Single- tuned amplifier
8. Automatic Gain Control Circuit
9. Frequency Mixer circuit.
10. IF amplifier

EL5225: Microprocessor 8086

Unit 1: Architecture of 8086 — 8 Hours

Introduction to Microprocessor: History and development, Buses, speed, memory. Microprocessor Overview, Intel 8086 Microprocessor: Architectural block diagram: Bus interface unit, Execution unit, pipelining, functional pin description, flags, data and address bus demultiplexing, Generation of 20-bit Address. Accessing odd and even memory bank, instruction cycle, fetch-execute cycles, timing diagrams - memory read, write, I/O write.

Unit 2: Instruction Set and Programming of 8086 — 12 Hours

Addressing modes: -Immediate, register, and Memory addressing modes. Instruction Sets - data transfer, arithmetic and logical, shift and rotate, branch, and machine control group. Programming: Examples; Data block exchange, addition, subtraction, multiplication, division of two 8 bit and 16 bit numbers, one's complement, two's complement, to find the number of ones in a given byte, Average of 10 numbers, Fibonacci series, smallest and largest numbers, Delay programs. Stack, Subroutine, Interrupts: - Types/classification of interrupts, Sources of 8086 interrupts, interrupt sequence, and vector table.

Unit 3: Memory Devices — 8 Hours

Need for memory devices, Memory Hierarchy, primary and secondary, real and virtual memory, volatile and non-volatile, Memory write ability and storage permanence, Types of semiconductor memories: - ROM, PROM, EPROM, EEPROM, Flash, RAM, SRAM, DRAM, PSRAM and NVRAM, cache memory, SSD.

Unit 4: Basic Peripherals and their Interfacing with 8086 — 12 Hours

Static RAM Interfacing with 8086, Interfacing I/O ports, Intel 8255 (PPI): Internal Block Diagram, modes of operation. Interfacing Keyboard and 7-Segment display using 8255.Traffic light control interface.Interfacing the keyboard and 7-Segment display using 8255.Traffic light control interface.

Interfacing ADC-0808/0809, DAC-0800, Stepper Motor using 8255, Timer 8254 – Mode 0, 1, 2 & 3, and Interfacing programmes for these modes.

Self-Study — 5 Hours

Memory-mapped I/O scheme, I/O mapped I/O scheme, DMA Intel 8257, Brief overview of Arithmetic coprocessor Intel 8087.

Text Books:

1. Ramesh S. Gaonkar, *Microprocessor Architecture, Programming and Applications with the 8086*, 6th Edition, Prentice-Hall of India, New Delhi, 2013.
2. M. Rafiquzzaman, Microprocessor Theory and Applications with 8086/8088, Prentice-Hall of India (PHI), New Delhi.

3. Douglas V. Hall, *Microprocessors and Interfacing: Programming and Hardware*, 2nd Edition, McGraw-Hill Education, New York, 2006.
4. M. Rafiquzzaman, Microprocessor Theory and Applications with 8086/8088, Prentice-Hall of India (PHI), New Delhi.

Reference Books:

5. A. K. Ray and K. M. Bhurchandi, *Advanced Microprocessors and Peripherals*, 3rd Edition, McGraw-Hill Education, New Delhi, 2012.
6. Walter A. Triebel and Avtar Singh, The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware and Applications, Prentice-Hall of India (PHI), New Delhi.
7. Scott Mueller, The Intel Microprocessors: 8086/8088, 80186, 80286, 80386, 80486—Architecture, Programming, and Interfacing, Techmedia Publishing, New Delhi.

Practical V – Paper 2

EL5P2: Practical (Intel 8086 ALPs using DOSBOX)

(11 sessions, 3 hours/week)

List of Experiments:

1. Data block exchange for different block sizes.
2. To interchange the data present in two different memory locations.
3. Addition and subtraction of two 8-bit and 16-bit numbers.
4. Multiplication of two 8-bit and 16-bit numbers.
5. Division of two 8-bit and 16-bit numbers.
6. To find the average of ten given 8-bit numbers.
7. To find the square and cube of a number.
8. To convert Binay to Gray code.
9. To find the smallest and largest numbers in an array.
10. To generate the Fibonacci series.
11. Smallest and largest numbers in an array.
12. Arranging a series of 8-bit numbers in ascending and descending order

ELE 5325: Data Acquisition and Instrumentation

Unit 1: Data acquisition and converters 08 Hours

Introduction, general data acquisition system (DAS), objectives, single-channel and multi-channel DAS block diagrams, qualitative description. Digital to Analog converter - R-2R ladder and binary weighted ladder circuits, brief analysis. D to A using an op-amp summing amplifier. Analog to Digital converter- Successive approximation method, Flash ADC, block diagram explanation and function generator (sine, square and triangular). Analog to Digital converter- Successive approximation method, Flash ADC, block diagram explanation, and function generator (sine, square, and triangular).

Unit 2: Sensors and transducers 14 Hours

Introduction, measurement characteristics (static), Definition of Sensor/Transducer, classification of transducers- Passive, active, digital, and analog types, examples. Electrical transducers/sensors, advantages. Selecting a transducer: Resistive transducers- Thermistor- construction, types, resistance- temp characteristics, applications. Resistance thermometer – construction, advantages, limitations. Thermocouple-Seebeck Effect, principle of operation, advantages, and disadvantages. Inductive transducers - Reluctance type - construction, working, Linear variable differential transformer (LVDT) -construction, working, advantages. Pressure Transducer, Capacitive Transducer, Resistance Transducer, Strain Gauge: Principles, Construction, Working, Photoelectric Transducers, Photovoltaic Cell, Photo Diode, and Photo Transistor- Working Principles, Applications. Piezoelectric transducer, working principle and and applications.

Unit 3: Measuring instruments 10 Hours

Digital voltmeter- features, performance characteristics, types: ramp type, dual slope type; block diagram, working principle, advantages and disadvantages.
Digital multimeter, Electronic Counter, Frequency meter, capacitance meter - Block diagram, working and applications, resolution and sensitivity of measuring instruments. Oscilloscopes-analog dual trace type, block description and principle of operation. Oscilloscopes: analog dual trace type, block description, and principle of operation.

Unit 4: Display devices 08 Hours

Principle, Working Mechanism and Applications: Seven Segment Display and its types, Liquid Crystal Display (LCD), Light Emitting Diode (LED) Display, Touch Screen (Resistive and Capacitive), Plasma Display, Organic LED (OLED) Display and Digital Light Processing (DLP) switch.

Self-Study 05 Hours

Introduction to Signal Conditioning in Instrumentation Systems, Instrumentation Amplifier, Measurements using CRO, Cathodic protections, IoT sensors.

Text Books

1. Electronic Instrumentation - H.S.Kalsi, 2nd Edition, TMH, 2005 Sensors and Transducers – D Patranabi
2. Transducers and Instrumentation – D. V. S. Murthy, 2nd Edition, New Age International Publishers, 2010.
3. Introduction to Measurements and Instrumentation – A. K. Ghosh, 4th Edition, PHI Learning, 2012.

Reference Books:

4. Instrumentation Measurement and Analysis – B. C. Nakra & K. K. Choudhury, 4th Edition, Tata McGraw-Hill, 2011.
5. Electronic Instrumentation and Measuring Techniques, W.D. Cooper, A.D. Helfrick, 3rd Edition, PHI, 2000
6. Instrumentation devices and systems, C.S.Rangan, G.R.Sarma, VSV Mani, TMH, 1998
7. Sensors and Transducers – Ian R. Sinclair
8. Principles of Industrial Instrumentation – Chennakesava R. Alavala, 1st Edition, Cengage Learning, 2009.
9. PC Interfacing for Data Acquisition and Process Control – S. Gupta & J. P. Gupta, 2nd Edition, PHI Learning, 2002.

Practical V – Paper IV

EL5P3: Practical (11 sessions, 3 hours/week)

List of Experiments:

1. Finding unknown capacitance using IC 555.
2. Study of Instrumentation amplifier.
3. Study of DAC using binary weighted resistors.
4. Current to voltage converter.
5. Voltage to current converter.
6. Finding unknown resistance using the Wheatstone bridge.
7. Study of R-2R ladder network.
8. Study of the loading effect of the voltmeter and correction using an Op-Amp buffer.
9. Characteristics of Photo-diode and photo-transistor.
10. LVDT and load cell.

Skill-1: PCB Design & Fabrication

Unit 1: Introduction to Printed Circuit Board 8 Hours

Basics of printed circuit board designing: Layout planning, general rules and parameters, ground conductor considerations, thermal issues, check and inspection of artwork. Design rules for PCB: Design rules for Digital circuit PCBs, Analog circuit PCBs, high frequency and fast pulse applications.

Unit 2: Overview of PCB design technology 8 Hours

Photo printing, film- master production, reprographic camera, basic process for double-sided PCBs photo resists, Screen printing process, plating, relative performance and quality control, etching machines, solders and alloys, fluxes, soldering techniques, Mechanical operations. Brief Introduction of various simulators, SPICE and PSPICE Environment, Selecting the Components Footprints as per design, Making New Footprints, Assigning Footprint to components, Net listing, Applications: Power electronic, Microwave, ORCAD.

Unit 3: Handon PCB subsystem design 14 Hours

PCB workflow from schematic to layout, footprint selection, manual and auto routing, silkscreen annotation, and generation of netlist, BOM, and Gerber files. Basic routing practice, design rule checking, and fabrication-ready output preparation. Subsystem integration, including PCB placement in enclosure, component placement, filtering circuits, and decoupling/bypass techniques. Basic noise reduction and signal integrity considerations.

Textbooks:

1. Printed circuit board design, fabrication, assembly, and testing by R. S. Khandpur, Tata McGraw-Hill, 2006.
2. EMC and Printed circuit board, Design theory and layout, Mark I Montrose, IEEE compatibility society.

Reference books:

3. Printed circuit Board Design and technology, Walter C. Bosshart
4. Printed Circuits Handbook, Sixth Edition, by Clyde F. Coombs, Jr, Happy T. Holden, Publisher: McGraw-Hill Education, Year: 2016
5. Complete PCB Design Using OrCAD Capture and PCB Editor, Kraig Mitzner, Bob Doe, Alexander Akulin, Anton Suponin, Dirk Müller, 2nd Edition 2009.
6. Introduction to System-on-Package, Rao R Tummala & Madhavan Swaminathan, McGraw Hill, 2008.

VI Semester

ELE6125: Advanced communication systems

Unit-1: Digital Communication System 15 Hours

Introduction to pulse communication systems and the need for pulse modulation. Concept of sampling and types of sampling: ideal (impulse), natural, and flat-top sampling. Sampling theorem, Nyquist rate, aliasing, and its prevention. Frequency-domain representation of sampling. Reconstruction of the original signal using an ideal low-pass filter. Practical limitations and applications of sampling in communication systems.

Digital communication systems – Introduction to digital modulations. FSK, BPSK, and ASK- brief description, waveforms, Advantages, and disadvantages of digital transmission. Applications. Characteristics of data transmission circuits: Shannon limit for information capacity, Bandwidth requirements, data transmission speeds, Noise, Crosstalk, Echo suppressors, Distortion, equalizer, and transmission impairment.

Unit 2: Satellite Communications 10 Hours

Introduction, Kepler's laws, satellite orbits, satellite system-block diagram of satellite sub-systems (space segment), station keeping, altitude control, ground station (simplified block diagram of earth station), uplink, downlink, cross-link, Transponder (C-band multi-channel), satellite bandwidth. Multiplexing types: FDMA, TDMA, CDMA, WCDMA, OFDMA. GPS –services like SPS & PPS.

Unit 3: Cellular Communication 6 Hours

Mobile communication overview, Cell Structure: Cell and cell splitting, frequency reuse, ARFCN, roaming, handoff. Security: SIM authentication, IMEI number, data encryption. System Design: Block diagram of a mobile communication network. GSM. Block diagram of a mobile handset.

Unit 4: Optical Fibre Communications 10 Hours

Introduction-need for optical fibre communication, Block diagram of OFC system, Core and clad concept, light propagation through optical fibre, Expressions for acceptance angle and numerical aperture. Modes of Propagation, Light sources - Requirements and examples. Construction and working of a LASER diode. Photo detector – PIN diode construction and working. Advantages and disadvantages of fibre optic communication, Losses in optical fibre - Rayleigh scattering, absorption, coupling, and bending.

Self-study: 4 Hours

Communication protocols, RJ45 connector and introduction to 5G.

Suggested Books:

1. Communication Systems, Simon Haykin & Michael Moher, Wiley India; 5th Edition, 2021.
2. Optical Fibers & Fiber Optic Communication Systems, Subir Kumar Sarkar – S. Chand & Co.; 4th Edition, 2014.

3. Satellite Communications by Timothy Pratt & Jeremy Allnutt, Wiley India, 3rd Edition, 2019.

Reference Book:

1. Digital and Analog Communication Systems by K. Sam Shanmugam, Wiley India, 2nd Edition, 2010.
2. Fundamentals of Optical Fibre Communication, M. Sathish Kumar – PHI Learning; 2nd Edition, 2025.
3. Satellite Communications: Principles and Applications by Anil K. Maini & Varsha Agrawal, Wiley India, 2nd/3rd Edition, ~2015.

Practical VI – Paper I

EL6P1: practical **(11 sessions, 3 hours/week)**

List of Experiments:

1. Second-order low-pass and high-pass filters
2. Twin filter
3. ASK modulation
4. FSK modulation
5. PSK modulation
6. PAM, PPM, PWM
7. Optical fiber experiment -Characterization of 660 nm LED
8. Setting up of Analog and Digital Link.
9. Numerical Aperture of a given fiber.
10. EM interference/bending losses

ELE6225: PIC microcontrollers and Embedded Systems

Unit1: Introduction to Microcontrollers **4 Hours**

Definition, need, types, Classification, General block diagram, types of architecture: - Harvard Vs Princeton, RISC Vs CISC, Differences between Microprocessor and Microcontroller, Examples of popular microcontrollers, applications (mention only).

Unit 2: PIC 16 Microcontroller architecture 10 Hours

Overview of PIC16 microcontroller, features and architecture. Block diagram and pin description. Memory organization: Program memory and data memory (GPR and SFR). System clock and oscillator circuits. Special Function Registers (SFRs) and General-Purpose Registers (GPRs), bit-addressable and byte-addressable registers. Reset circuit and power-on reset. Interrupt structure. I/O ports and configuration. Timers/Counters.

Unit 3: Instruction Set and Programming 15 Hours

Addressing modes: Immediate, Direct, Register, Register Indirect, Indexed, and Implied addressing modes—definitions and examples. Instruction set: Data transfer instructions, arithmetic instructions, logical instructions, branching operations, subroutines, and call/return instructions.

Assembly language programming examples: Data transfer operations using internal memory, 8-bit arithmetic operations: addition, subtraction, multiplication, and division, logical operations and truth table verification, sorting of numbers in an array, implementation of BCD and hexadecimal counters,

Interfacing using PIC16 microcontroller: LED, relay, stepper motor, ADC, DAC, PWM.

Unit 5: Introduction to Embedded Systems **12 Hours**

Embedded Systems Overview, General block diagram, characteristics, Design Constraints – Optimizing Design Metrics. Embedded System processor technology: General-purpose processor, Single-purpose processor and Application-specific processor (ASIP). Standard Single Purpose Processors, Custom single-purpose processor design,

Self-study **4 Hours**

Introduction: ARM processors, Arduino development board (Applications), card reading. Introduction: ARM processors, Arduino development board (Applications), and card reading.

Text Books:

1. PIC Microcontrollers – Nebojsa Matic, 1st Edition, mikroElektronika, 2003.
2. Design with PIC Microcontrollers – John B. Peatman, 1st Edition, Pearson Education, 2002.
3. Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, McGraw-Hill Education, New Delhi.

Reference Book

4. The Quintessential PIC Microcontroller – Sid Katzen, 2nd Edition, Springer, 2005.
5. PIC Microcontroller: An Introduction to Software and Hardware Interfacing – Nan-Weay Huang, 1st Edition, Thomson Delmar Learning, 2005.

6. Programming and Customizing the PIC Microcontroller – Myke Predko, 3rd Edition, McGraw-Hill, 2001.
7. David E. Simon, *An Embedded Software Primer*, Addison-Wesley Professional, Boston, 2000.
8. Frank Vahid and Tony Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley India, New Delhi, 2002.
9. Andrew N. Sloss, Dominic Symes, and Chris Wright, *ARM System Developer's Guide*, Morgan Kaufmann Publishers, USA, 2004.

Practical VI-Paper II

EL6P2: Practical: (11 sessions 4 hours/week)

List of Experiments

1. Data transfer between General Purpose Registers (GPR).
2. 8-bit addition and subtraction of two numbers.
3. Multiplication of two 8-bit numbers.
4. Division of two 8-bit numbers.
5. Logical operations: AND, OR, XOR on given data.
6. Program to find the largest number in an array.
7. Program to sort numbers in ascending order.
8. Program to implement the BCD counter.
9. Program to implement a hexadecimal counter.
10. LED blinking program using PIC16 I/O port.
11. Switch input reading and LED output display.
12. Program to generate software delay using registers.

EL6325: Introduction to IoT and Robotics

Unit 1: Fundamentals of IoT and communication protocols **6 Hours**

Definition and evolution of the Internet of Things. IoT architecture: perception, network, and application layers. real-world applications (smart cities, home automation), Classification of IoT. IoT communication protocols: MQTT, CoAP, HTTP. Characteristics of sensors and actuators used in IoT.

Unit 2: IoT design Technology **12 Hours**

Wireless communication technologies for IoT: Wi-Fi, Bluetooth, Zigbee, LoRa, WAN. Pin configuration and architecture of Raspberry Pi, Node MCU, and ESP 32 modules (Overview only). IoT network topologies: star, mesh, and hybrid networks. IoT data management and storage. IoT protocols for device-to-device and device-to-cloud communication. IoT application development platforms and frameworks. IoT security challenges and solutions. Privacy and ethical considerations in IoT.

Unit 3: Microcontrollers and their interfacing in a robotic system **15 Hours**

Definitions of robots, motivation, history of robotics, interdisciplinary areas in robotics, and classification of robots. IDE installation. characteristics of sensors (contact & non-contact) and actuators used in robotics, Interfacing of motors (DC, servo, stepper), relays, buzzers, Locomotion types: wheels, legs, tracks, Line following and obstacle avoidance (concepts only), motor drivers (L298N, TB6612)

Unit 4: Programming platform of Robots **10 Hours**

Introduction to Embedded C platform, Review of Basic Concepts, Arduino data types, Variables and constants, Operators, Control Statements, Arrays Functions, I/o Functions, Pins Configured as INPUT, Pins Configured as OUTPUT, Incorporating time delay () function, delay Microseconds () function, millis() function, micros () function.

Self-study: **04 Hours**

Introduction to cloud computing with IoT devices.

Text Books:

1. Internet of Things: Principles and Paradigms by Rajkumar Buyya, Amir, Vahid Dastjerdi, and Anton Y. Dongarra.
2. Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry by MaciejKranz.
3. Fundamentals of Robotics by D K Pratihar.
4. Introduction to Robotics | Fourth Edition by John Craig.

Reference Book:

1. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things by David Hanes, Gonzalo Salgueiro, Patrick Grossetete, and Robert Barton.
2. Internet of Things with Arduino Cookbook" by Marco Schwartz
3. Arduino Home Automation Projects" by Marco Schwartz and Oliver Manickum
4. Robotics Simplified: An Illustrative Guide to Learn Fundamentals of Robotics, by Dr. Jisu Elsa Jacob, Manjunath N.

5. Arduino Robotics by John-David Warren (Author), Josh Adamsduino.

Practical VI-Paper 3

EL6P3: Practical: (11 sessions, 4 hours/week)

List of experiments:

1. Starting Raspbian OS, Familiarization with Raspberry Pi components and interface, Connecting to Ethernet, Monitor, USB.
2. Interfacing a push button with Raspberry Pi and displaying input status.
3. Interfacing a buzzer and generating different sound patterns.
4. Temperature measurement using LM35/DHT11 sensor and displaying values.
5. Humidity monitoring using DHT11/DHT22 sensor.
6. Interfacing an LDR for light intensity measurement.
7. Controlling a DC motor using a motor driver module.
8. Servo motor control using Raspberry Pi GPIO.
9. Interfacing a relay module for switching AC appliances
10. Serial communication between Raspberry Pi and Arduino/PC.
11. Displaying Time over a 4-Digit 7-Segment display using Raspberry Pi.

Skill-2: Verilog HDL and FPGA Design

Unit 1 : Introduction to Verilog HDL **8 Hours**

Introduction, design flow, Use of Verilog, hierarchical modeling concepts, design methodology, Introduction to modules, instances, Basic Concepts: Lexical Conventions, data types: value set, nets, registers, vectors, arrays, parameters, memories, strings. System tasks and compiler directives. Introduction to modules, instances, Modules, and Ports, hierarchical names.

Unit 2: Overview of Verilog modeling **8 Hours**

Gate level modeling: Gate types- AND/OR, BUF/NOT, multiplexer, full adder, Gate delays: Rise, Fall, Turn off delays, min/typ/max values.

Data flow modeling: Continuous assignments, delays, expressions, operators, and operands, operator types with examples.

Behavioural modeling: Structural procedure, procedural assignments, Timing controls: Delay Based, Event Based, Level Sensitive, conditional statements, loops, sequential and parallel blocks. Tasks and Functions: Introduction to Tasks, Introduction to Functions, Differences between Tasks and Functions.

Unit 4: Implementation of digital subsystems using FPGA kit **14 Hours**

EDA Tools: Vivado overview, Introduction to FPGA and CPLD**,** architecture**,** power-up procedure, and development tools installation. Demonstration program to blink LEDs, Implementation of basic logic gates (AND, OR, NOT, NAND, NOR, XOR), Implementation of half adder/subtractor and full adder/ full subtractor, magnitude comparator, design of synchronous and asynchronous counters, design of shift registers (SISO, SIPO, PISO, PIPO), seven-segment display interfacing using. Interfacing push buttons and switches for digital input control, LED pattern generation.

Suggested books:

1. Verilog HDL: A Guide to Digital Design and Synthesis – Samir Palnitkar
2. A Verilog HDL Primer, J. Bhasker, 30 August 1999.
3. Digital system design with FPGA: implementation using Verilog and VHDL by Cem Unsal, Bora Tar, 2017.

Reference books:

1. Fundamentals of digital circuits: A Anand Kumar, PHI, 3rd edition 2004
2. Digital Design Using Verilog HDL, Dr. D A Godse, A P Godse, Tech publication, 2020.
3. The FPGA Programming Handbook – Second Edition: An essential guide to FPGA design for transforming ideas into hardware using System Verilog and VHDL, Frank Bruno, Guy Eschfemann, 2024.

Question Paper Pattern

Exam duration: 2hrs **Total marks: 60**

Part A	**MCQ (Answer all)**	**1x10 = 10**
Part B	**Descriptive (Answer any 5 out of 7)**	**6x5 = 30**
Part C	**Numerical (Answer any 5 out of 7)**	**4x5 = 20**
Total		**60**