



CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025-26/294 dated 06.08.2025

In supersession to the above referred Circular, the structure and syllabus of Semester III and IV of the **Master of Science in Electronics** Programme comprising the RSE and GE Courses approved by the Standing Committee of the Academic Council in its meeting held 24th & 25th November 2025 and DSVE Courses approved by the Standing Committee of the Academic Council in its meeting held on 24th February 2026 is attached.

Further, the Syllabus of Semester I and II approved earlier by the Standing Committee of the Academic Council in its meeting held on 24th & 25th June 2025 is also attached.

The Dean & Vice-Dean (Academic) of the School of Physical and Applied Sciences are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, School of Physical and Applied Sciences, Goa University.
2. The Vice-Dean (Academic), School of Physical and Applied Sciences, Goa University.

Copy to:

3. Chairperson, BoS in Electronics, Goa University.
4. Programme Director, M.Sc. Electronics, Goa University.
5. Controller of Examinations, Goa University.
6. Assistant Registrar Examinations (PG), Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY
MASTER OF SCIENCE IN ELECTRONICS
(Effective from the Academic Year 2025-26)

ABOUT THE PROGRAMME

The School of Physical and Applied Sciences is a result of the amalgamation of three correlated departments which belonged to the erstwhile Faculty of Natural Sciences. Department of Electronics, on the other hand, was established in 2010, centred around the M.Sc. Electronics programme started by the Physics department in 1992. Department of Electronics was identified by UGC to initiate Innovative program in Embedded Technologies. The success of the program is a result of the foundations of a vibrant academic culture and significant contributions of several of our distinguished personalities.

OBJECTIVES OF THE PROGRAMME

Presently the thrust area of the program is in areas of embedded system, agro-electronics, Signal and Image processing, robotics and Smart instrumentation. The main objectives of the curriculum are to train and have hand-on experience for the pupil in the area of embedded technologies having application in data communication, signal, image processing and smart instrumentation so that they are employable in the industry.

PROGRAMME SPECIFIC OUTCOMES (PSO)

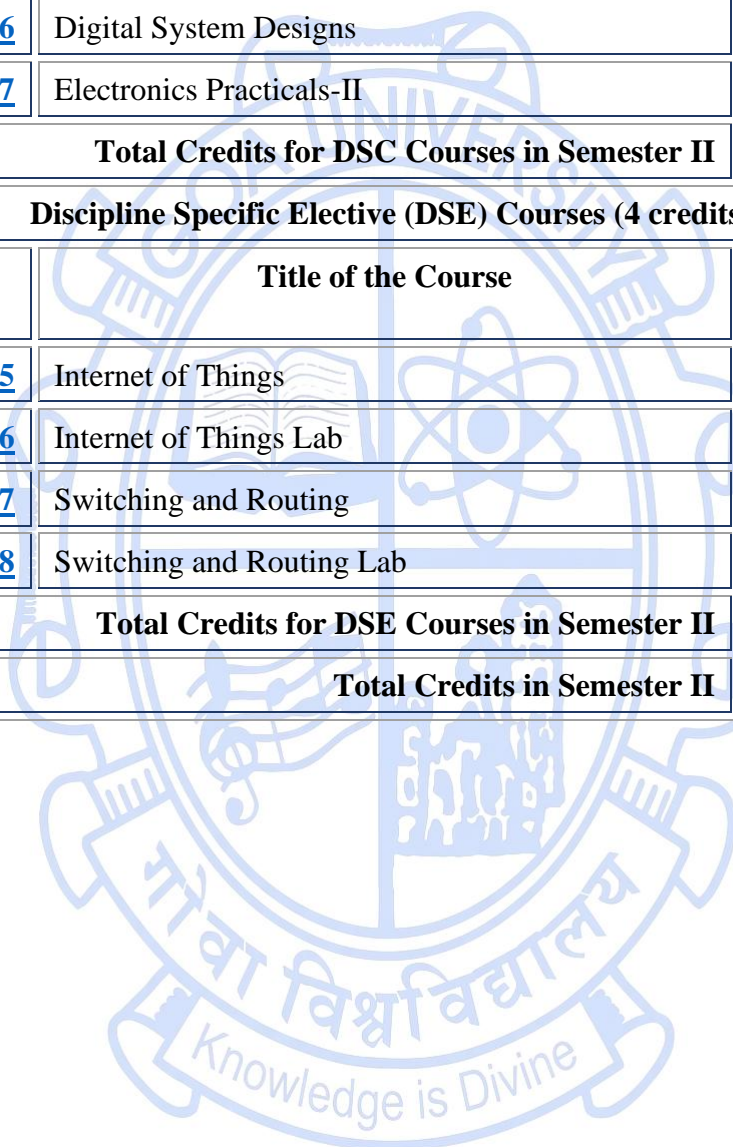
PSO 1.	Gain profound knowledge about Embedded systems, the Internet of things (IoT), Artificial Intelligence (AI) and Electric vehicles technology.
PSO 2.	Implementing the experiments on Embedded systems, Programmable logic, IP cores like soft-core processors, having applications in Control systems & Robotics, Smart Sensors instrumentation, and Biomedical.
PSO 3.	Applying the concepts of signals-system and various Machine learning techniques for applications like agro-electronics, Image processing, Neural system, Biomedical etc.
PSO 4.	Analysing performance metric of Machine learning algorithms and various embedded platforms.
PSO 5.	Developing a technological solution to societal problems by utilizing state-of-the-art technologies.
PSO 6.	Understand and analyse the principles of digital communication and optical technologies.

PROGRAMME STRUCTURE
Master of Science in Electronics
Effective from Academic Year 2025-26

Bridge Course			
Sr. No.	Course Code	Title of the Course	Credits
1	<u>ELE-1000</u>	Introduction to Electronics	02

Semester I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	<u>ELE-5000</u>	Micro Electronics and VLSI Design	4T	400
2	<u>ELE-5001</u>	Signals and Systems	4T	400
3	<u>ELE-5002</u>	Embedded System Design	4T	400
4	<u>ELE-5003</u>	Electronics Practicals-I	4P	400
Total Credits for DSC Courses in Semester I			16	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	<u>ELE-5201</u>	EDA Tools	2T	400
2	<u>ELE-5202</u>	EDA Tools Lab	2P	400
3	<u>ELE-5203</u>	Numerical Computation and Algorithms	2T	400
4	<u>ELE-5204</u>	Numerical Computation and Algorithms Lab	2P	400
Total Credits for DSE Courses in Semester I			4	
Total Credits in Semester I			20	

Semester II				
Discipline Specific Core (DSC) Courses				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	ELE-5004	Advanced Digital Communication System	4T	500
2	ELE-5005	Real Time Operating Systems	4T	500
3	ELE-5006	Digital System Designs	4T	500
4	ELE-5007	Electronics Practicals-II	4P	500
Total Credits for DSC Courses in Semester II			16	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	ELE-5205	Internet of Things	2T	400
2	ELE-5206	Internet of Things Lab	2P	400
3	ELE-5207	Switching and Routing	2T	400
4	ELE-5208	Switching and Routing Lab	2P	400
Total Credits for DSE Courses in Semester II			4	
Total Credits in Semester II			20	



Semester III				
Research Specific Elective (RSE) Courses (12 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	ELE-6000	Research Methodology	3T	500
2	ELE-6001	Research Methodology Lab	1P	500
3	ELE-6002	Artificial Intelligence and Applications	3T	500
4	ELE-6003	Artificial Intelligence and Applications Lab	1P	500
5	ELE-6004	Instrumentation & Control Theory	3T	500
6	ELE-6005	Instrumentation & Control Theory Lab	1P	500
7	ELE-6006	Data Science and Machine Learning	3T	500
8	ELE-6007	Data Science and Machine Learning Lab	1P	500
9	ELE-6008	Swayam -I	4T	500
Total Credits for RSE Courses in Semester III			12	
Discipline Specific Vocational Elective (DSVE) Courses (8 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	ELE-6401	Laser System Engineering	2T +2P	500
2	ELE-6402	Biometrics	2T +2P	500
3	ELE-6403	Biomedical Instrumentation	2T +2P	500
Total Credits for DSVE Courses in Semester III			8	
Total Credits in Semester III			20	

Discipline Specific Dissertation (DSD) (40 Credit Dissertation)				
**Including 4 Credits Course/s of Research Methodology and a 4 credit Dissertation-related Courses to be opted in consultation with the guide.				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	ELE-6501	Dissertation -1	32P	500

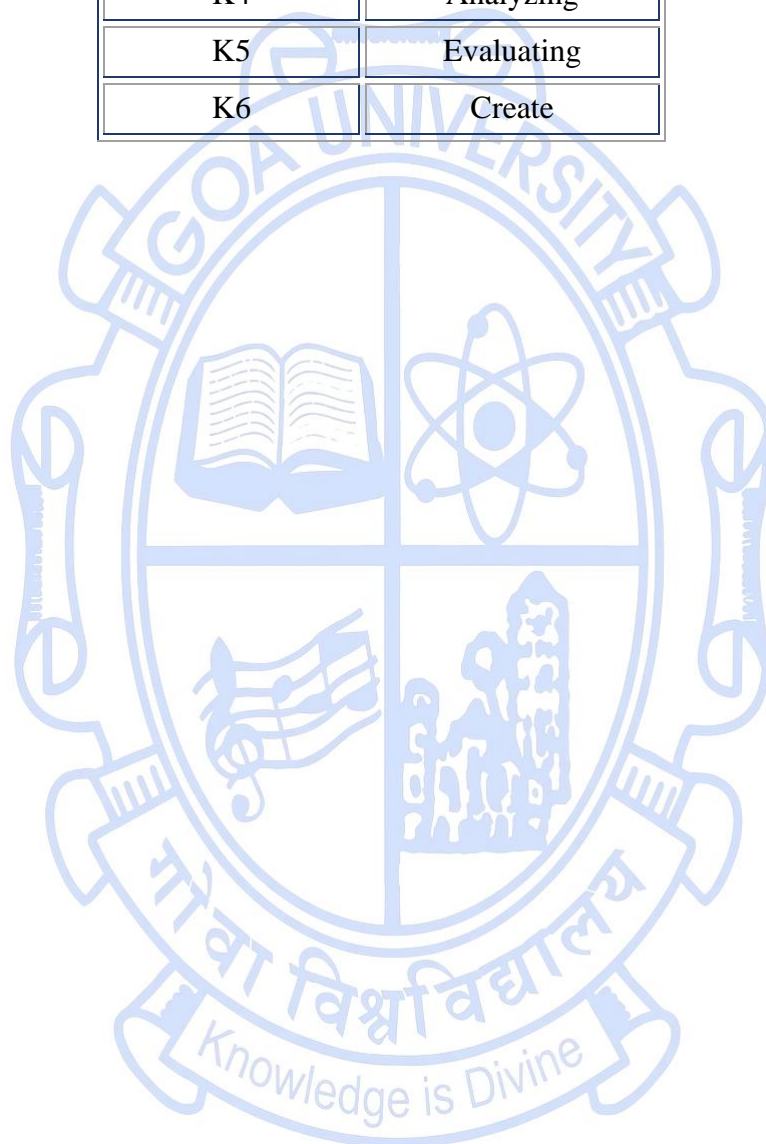
Semester IV				
Generic Elective (GE) Courses (20 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	ELE-6201	Optical Communication Systems	3T	500
2	ELE-6202	Optical Communication Systems Lab	1P	500
3	ELE-6203	Digital Image Processing	3T	500
4	ELE-6204	Digital Image Processing Lab	1P	500
5	ELE-6205	Neuromorphic Computing	3T	500
6	ELE-6206	Neuromorphic Computing Lab	1P	500
7	ELE-6207	Electric Vehicle Technology	3T	500
8	ELE-6208	Electric Vehicle Technology Lab	1P	500
9	ELE-6209	Data Analysis and Visualization	3T	500
10	ELE-6210	Data Analysis and Visualization Lab	1P	500
11	ELE-6211	Edge Computing	3T	500
12	ELE-6212	Edge Computing Lab	1P	500
13	ELE-6213	Robotics	3T	500
14	ELE-6214	Robotics Lab	1P	500
15	ELE-6215	Swayam-II	4T	500
Total Credits for GE Courses in Semester IV			20	

Discipline Specific Dissertation (DSD)/ Internship (20 Credit Dissertation)				
* - Including 4 Credits of Research Methodology/Dissertation-related Courses to be opted in consultation with the guide.				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	ELE-6502	Dissertation -2	16P	500
Total Credits in Semester IV			20	

Note :

- Semester I & II are common for Students opting for 40, 20 dissertation and non-dissertation students.

Blooms Taxonomy Cognitive Levels	
Cognitive Level	Notations
K1	Remembering
K2	Understanding
K3	Applying
K4	Analyzing
K5	Evaluating
K6	Create



BRIDGE COURSE

Title of the Course	Introduction to Electronics	
Course Code	ELE-1000	
Number of Credits	2	
Theory/Practical	Theory	
Level	400	
Effective from AY	2025-2026	
New Course	Yes	
Bridge Course/ Value added Course	Yes	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	This course is intended to: <ul style="list-style-type: none">• Introduce fundamental passive components used in electrical and electronic circuits.• Provide a fundamental understanding of semiconductor devices and applications in basic electronic circuits.• Getting familiar with IC's and building different applications using IC's.• To introduce the foundation of communication techniques.	
Course Outcomes:		Mapped to PSO
	CO 1. Identify and classify different passive components like resistors, capacitors, and inductors.	PSO 1

	CO 2. Identify and distinguish between active components (Diode, BJT, FET)		PSO 1	
	CO 3. Understanding of OP-AMP, 555 timers, Regulated IC's and Fabrication of integrated circuits.		PSO 1	
	CO 4. To understand and apply the basic analog communication techniques		PSO 1	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	<p>Introduction to active and Passive Components: Definition and role in circuits.</p> <p>Resistors: Basics of resistors, types, tolerance, color coding, power rating, series and parallel connections</p> <p>Capacitors: Basics of capacitors, types, Capacitance, tolerance, voltage rating, charging and discharging behavior, series and parallel connections</p> <p>Inductors: Basic concepts of inductance, types, Mutual coupled coils</p> <p>Semiconductor Diode: P-N junction diode, diode characteristics, Zener & avalanche breakdown Diode as rectifier.</p> <p>Bipolar Junction Transistor (BJT): PNP and NPN transistor, CB, CE and CC configurations.</p> <p>Field Effect Transistor (FET): Construction, operation, characteristics and Biasing of Junction FET.</p>	15	CO1, CO2	K1, K2, K3
Module 2:	<p>OP-AMP: Block diagram of OP-AMP, Differential Amplifier configurations, Differential amplifier analysis, characteristics of OP-AMP, applications of OP-AMP.</p> <p>TIMERS: NE 555 timer, working principles, 555 timers as Astable, Monostable and voltage controlled oscillator, and PLL.</p> <p>Regulated IC: 78 & 79 series, IC723, LM317, Line regulation, Load regulation</p> <p>Fabrication of IC's: Advantages of IC's, Epitaxial process, Fabrication of monolithic</p>	15	CO3, CO4	K1, K2, K3

	components: NPN and PNP transistors, diodes, resistors and capacitors.			
	Introduction to communication: Block of communication system, Necessity of modulation, Electromagnetic communication spectrum. Amplitude Modulation, Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum.			
Pedagogy:	Lectures/Experiential Learning/Presentations			
Texts:	<ol style="list-style-type: none"> 1. A. K. Sawhney, 'A Course in Electrical and Electronic Measurements and Instrumentation', Dhanpat Rai & Co, 19th Edition, 2020 2. N. N. Bhargava, D. C. Kulshreshtha, S. C. Gupta, 'Basic Electronics and Linear Circuits', Tata MacGraw Hill, 2nd Edition, 2017 3. Ramakant Gayakwad, 'Op-Amps and Linear Integrated Circuits', 4th Edition, Prentice Hall, 2015. 4. George Keneddy, 'Electronics Communication Systems', McGraw Hill Education; 5th edition, 2011 			
References/ Readings:	<ol style="list-style-type: none"> 1. S. Salivahan, N. Suresh Kumar, 'Electronics Devices and Circuits', 3th Edition, McGraw Hill Education , 2017. 2. Jacob Millman, Christos Halkias, Chetan Parikh, 'Integrated Electronics - Analog And Digital Circuits And Systems, 2nd Edition, 2018 3. Robert F. Coughlin, Frederick F. Driscoll, 'Operational Amplifiers and Linear Integrated Circuits, 5th Edition, Pearson, 1997 4. D Roy Choudhury, Shail B Jain, 'Linear Integrated Circuits', 6th Edition, New Age International Private Limited, 2021 5. Simon Haykin, Michael Moher, 'Communication Systems', 4th Edition, Wiley, 2006 			

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SEMESTER I

Discipline Specific Core (DSC) Courses

Title of the Course	Micro Electronics and VLSI Design	
Course Code	ELE-5000	
Number of Credits	04	
Theory/Practical	Theory	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	This course is intended to: <ul style="list-style-type: none">• Introduce to the VLSI Technology, various fabrications processes involved in IC design ,• Analysis of Electronics circuits, Design examples of VLSI circuits, Circuit Optimization techniques• Advance circuits designs: Memory, Registers, Synchronous circuits etc.	
Course Outcomes:		Mapped to PSO
	CO 1. Understanding design of fundamental gates and customize them for specific electrical and electronics application,	PSO 1

	CO 2. Understand the fabrications processes involved in VLSI technology,		PSO 5	
	CO 3. Apply, Analyze and evaluate the synchronization of combinational and sequential circuits, memory cell and memory array circuits.		PSO 2	
	CO 4. Evaluating Advanced digital circuits and Programmable logics		PSO 2	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	An overview of VLSI, Modern CMOS Technology Silicon Logic, Logic design with MOSFET.	15	CO1, CO2	K1, K2
Module 2:	Physical structure of CMOS Integrated circuits Fabrication Technologies of CMOS Integrated Circuits Elements of Physical Design	15	CO1, CO2, CO3	K1, K2, K3
Module 3:	Electrical characteristics of MOSFETS Electronic analysis of CMOS Logic gates	15	CO3	K4
Module 4:	Advanced Techniques in CMOS Logic Circuits System specifications using HDL, General VLSI components Memories and Programmable Logic	15	CO3, CO4	K5
Pedagogy:	Lectures/Experiential Learning			
Texts:	Introduction to VLSI Circuits and Systems, John P. Uyemura, WILLEY.			
References/ Readings:	<ol style="list-style-type: none"> 1. Principles of CMOS VLSI Design, N.H.E. W. & Eshahiraghian, Addison Wesley 2. Modern VLSI Design System on Silicon, Pearson Education Asia. By W. Wolf. 3. VLSI Technology, S.M. Sze, McGraw -Hill (1995). 5. Basic VLSI Design, Douglas Pucknell, K. Eshraghian, Prentice Hall India. 			
Web Resources:	https://www.semiconductors.org/resources/2015-international-technology-roadmap-for-semiconductors-itrs/			

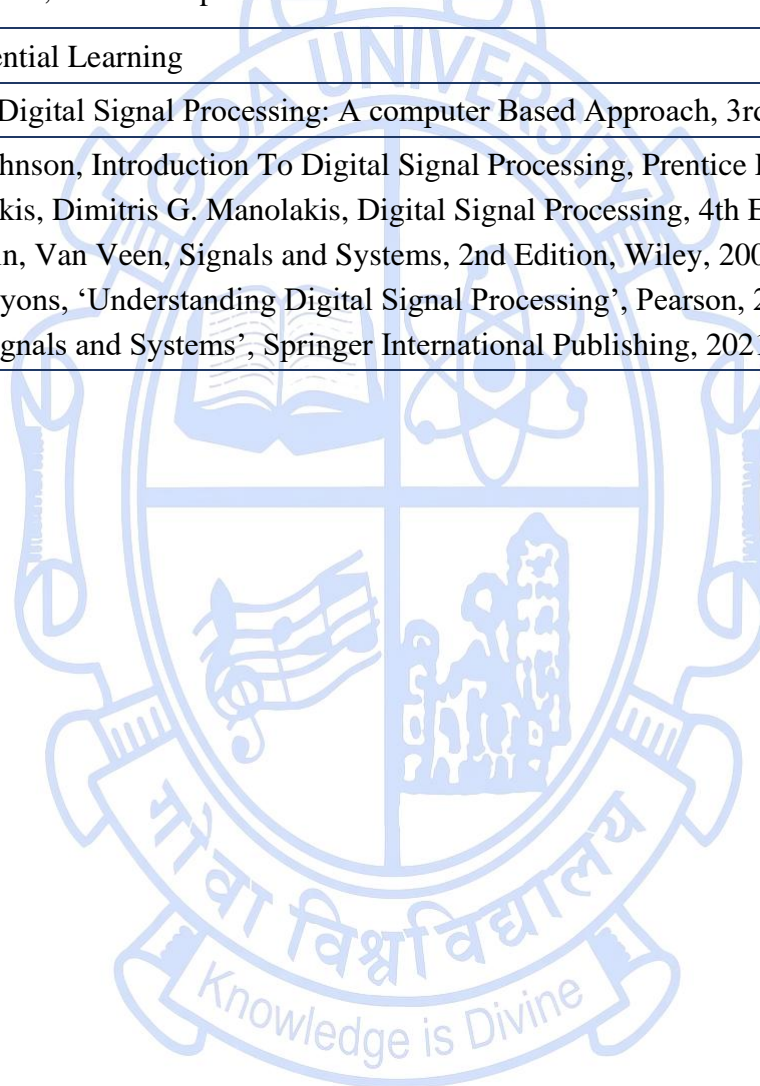
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Title of the Course	Signals and Systems	
Course Code	ELE-5001	
Number of Credits	04	
Theory/Practical	Theory	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to</p> <ul style="list-style-type: none"> • Introduce the fundamentals of signals and systems, including signal characterization and basic processing operations. • Develop an understanding of discrete-time signals and systems, and the methods of analysing them. • Provide a comprehensive understanding of the Fourier, Laplace, and other transforms used in signal analysis. • Explore digital filter structures and design techniques for FIR and IIR filters. 	
Course Outcomes:		Mapped to PSO
	CO 1. Classify and analyse different types of signals and understand basic signal processing operations and DSP practical applications.	PSO 3

	CO 2. Apply mathematical models to describe discrete-time signals and systems, including sampling and correlation.		PSO 3	
	CO 3. Compute and interpret various transforms (Fourier, Laplace, Wavelet, STFT) for signal analysis.		PSO 3	
	CO 4. Design and analyse FIR and IIR digital filter structures		PSO 3	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1.1 Characterization and Classification of Signals, Typical Signal Processing Operations	06	CO1	K1, K2
	1.2 Discrete-Time Signals, Sequence Representation, Sampling Process, Simple Interconnection Schemes, Convolution, Correlation of Signals	09	CO2	K2
Module 2:	2.1 Fourier series, Continuous and Discrete-time Fourier Transform, Laplace Transform,	07	CO2, CO3	K1, K2, K3
	2.2 Energy Density Spectrum, Phase and Group Delays	04	CO3	K1, K2
	2.3 Short-Time Fourier Transform, Wavelet Transform	04	CO2, CO3	K1, K2, K3
Module 3:	3.1 Digital Processing of Continuous Time Signals - Sampling of Continuous Time Signal, Low-pass & Band-pass Signal, Anti-Aliasing, Sample-and-Hold (S/H)	04	CO2, CO3	K2
	3.2 Digital Filter Structure - Block Diagram Representation, FIR, IIR filter, Allpass Filter, Tunable IIR Digital Filter, Digital Sin-Cosine Generator.	07	CO2, CO3	K4, K5
	3.3 FIR Digital Filter Design - Preliminary Considerations, FIR Filter Design Based on Windowed Fourier Series	04	CO2, CO3	K4, K5
Module 4:	4.1 DSP Algorithm Implementation - Computability Equation Describing Filter Structure, Verification, Number Representation, Handling Overflow	07	CO1	K4, K5

	4.2 Dual-Tone Multi-Frequency Signal Detection, Musical Sound Processing, Signal Compression, Transmultiplexers	08	CO1	K4
Pedagogy:	Lectures/Experiential Learning			
Texts:	Sanjit K Mitra, 'Digital Signal Processing: A computer Based Approach, 3rd Edition, Tata MacGraw-Hill, 2011			
References/ Readings:	<ol style="list-style-type: none"> 1. Johnny R. Johnson, Introduction To Digital Signal Processing, Prentice Hall, 1989. 2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, 4th Edition, Pearson Education, 2007. 3. Simon Haykin, Van Veen, Signals and Systems, 2nd Edition, Wiley, 2007 4. Richard G. Lyons, 'Understanding Digital Signal Processing', Pearson, 2022 5. S. Palani, 'Signals and Systems', Springer International Publishing, 2021 			

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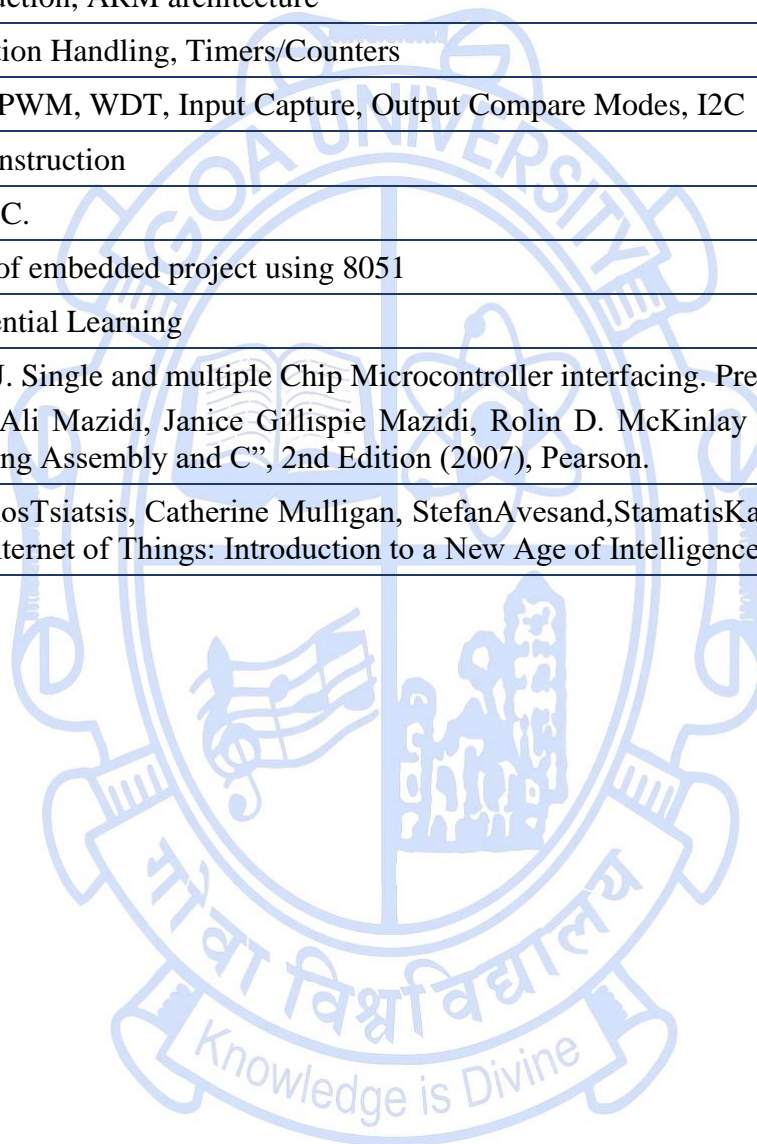


Title of the Course	Embedded System Design	
Course Code	ELE-5002	
Number of Credits	04	
Theory/Practical	Theory	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	NIL	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Introduce with Architectures of Microcontroller and its programming with Interfacing various Interfaces is discussed in depth in this paper. • Programming in assembly as well as in C for 8/16/32 bit controller • Implementation of embedded system projects 	
Course Outcomes:		Mapped to PSO
	CO 1. Understand the architecture and programming of microcontrollers and embedded processors.	PSO 1
	CO 2. Apply knowledge of embedded system hardware components such as sensors, actuators, memory, and communication interfaces.	PSO 1

	CO 3. Develop embedded C programs for microcontrollers (e.g., 8051, PIC, ARM) to perform real-time tasks.		PSO 5	
	CO 4. Design and simulate embedded systems for real-time applications using suitable development tools and environments.		PSO2, PSO 5	
	CO 5. Integrate hardware and software to create a working embedded solution for given specifications.		PSO5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction to Controller	Computer Architecture, RISC/CISC and Princeton Architectures	5	CO1	K1, K2
Module 2: Embedded system	Definition, Basic Block, Designing of System, Applications	5	CO1	K1, K2, K3
Module 3: 8-bit Micro controller	3.1 Introduction to various 8-Bit microcontroller, 8051 features, Architecture	3	CO1	K1, K2
	3.2 Memory organization, Instruction set	4	CO1	K2, K3
	3.3 Interrupts, Timer/counter, LED, Switches, ADC, DAC, LCD Interfacing,	4	CO2	K2, K3
	3.4 Programming in Assembly and C	4	CO3	K3, K4, K5
	3.4 Implementation of embedded project using 8051	4	CO4, CO5	K2, K3, K6
Module 4: 16-bit Micro controllers	4.1 PIC controller Introduction, Architecture	2	CO1	K1, K2
	4.2 Instruction set	4	CO1	K2
	4.3 Peripheral interfaces: LED, LCD, Serial RS232	3	CO2	K3
	4.4 Programming in C	2	CO3	K3, K4, K5
	Implementation of embedded project using PIC	4	CO4, CO5	K2, K3, K6

Module 5: 32-bit Micro controllers	5.1 ARM Introduction, ARM architecture	2	CO1	K2
	5.2 ARM Exception Handling, Timers/Counters	2	CO1	K1, K2
	5.3 UART, SPI, PWM, WDT, Input Capture, Output Compare Modes, I2C	3	CO2	K2
	THUMB/ARM instruction	2	CO1	K2
	Programming in C.	2	CO3	K3, K4, K5
	Implementation of embedded project using 8051	4	CO4, CO5	K2, K3, K6
Pedagogy:	Lectures/Experiential Learning			
Texts:	<ol style="list-style-type: none"> 1. Lipovski G. J. Single and multiple Chip Microcontroller interfacing. Prentice Hall, USA 1998. 2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, 2nd Edition (2007), Pearson. 			
References/ Readings:	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, StefanAvesand,StamatisKarnouskos, David Boyle, “From Machine-to-Machine to theInternet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.			

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Title of the Course	Electronics Practicals -I
Course Code	ELE-5003
Number of Credits	04
Theory/Practical	Practicals
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Give the hands-on experience to design the basic digital and analog circuits • Simulate the various digital modulation techniques and data correction and detection used in general communication system. • Expose students to design digital circuits using microwind. • Implement numerical algorithm. • To provide practical knowledge of implementing digital signal processing techniques such as filtering, aliasing, interpolation, DFT, and FFT algorithms. • Design and implement system models using transfer functions and convolution operations for signal analysis and transformation.

Course Outcomes:		Mapped to PSO		
	CO 1. learn the basics of a communication system for modulation, data coding, error coding channel coding methods.	PSO 1		
	CO 2. Design signal conditioning and VLSI circuits for various applications.	PSO 2		
	CO 3. Apply, Analyse and evaluate the synchronization of combinational and sequential circuits, memory cell and memory array circuits.	PSO 3		
	CO 4. Implement and analyze digital filters, demonstrate the effects of aliasing, and interpolation	PSO 3		
	CO 5. Develop and implement DFT, FFT, and convolution-based systems to perform frequency-domain and time-domain analysis.	PSO 3		
	CO 6. Design applications using Various embedded platforms			
Content:	Note: Minimum 4 experiments are to be performed from Each Module	No of hours	Mapped to CO	Cognitive Level
Module 1:	<ol style="list-style-type: none"> 1. Design of counters for digital clock (using Microwind s/w) 2. Multiplexer and Demultiplexer (using Microwind s/w) 3. Encoder and Decoder (using Microwind s/w) 4. 2nd order Butter-worth Notch Filter (p-Spice) 5. Buffer design using SPICE (p-Spice) 6. Memory design using 6T cell 	40	CO1, CO2, CO3	K4, K5, K6
Module 2:	<ol style="list-style-type: none"> 1. Implementation of Filters – Ensemble Average filter, Exponential weighted running system, Median Filter. 2. Implementation of the aliasing effect 3. Implementation of interpolation 4. Implementation of DFT and FFT algorithms 5. Design Transfer function and convolution 	40	CO1	K3, K4, K6

Module 3:	<ol style="list-style-type: none"> 1. Design of variable Power Supply for 2Amp with Load and Line regulation. 2. Design of Function generator 3. Design of Stepper drive with monoshot 4. Serial Transmission and reception PIC16F877 5. Data acquisition with ADC PIC16F877 on microcontroller 6. Hex Keypad Interfaced to ARM controller & display on LCD 	40	CO 6	K2, K3, K4, K6
Pedagogy:	Presentations /assignments/Experiential learning			
Texts:	<ol style="list-style-type: none"> 1. Introduction to VLSI Circuits and Systems, John P. Uyemura, WILLEY. 2. Sanjit K Mitra, 'Digital Signal Processing: A computer Based Approach, 3rd Edition, Tata MacGraw-Hill, 2011 3. Lipovski G. J. Single and multiple Chip Microcontroller interfacing. Prentice Hall, USA 1998. 			
References/ Readings:	<ol style="list-style-type: none"> 1. Principles of CMOS VLSI Design, N.H.E. W. & Eshahiraghian, Addison Wesley 2. Basic VLSI Design, Douglas Pucknell, K. Eshraghian, Prentice Hall India. 3. Johnny R. Johnson, Introduction To Digital Signal Processing, Prentice Hall, 1989. 4. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, 4th Edition, Pearson Education, 2007. 5. Simon Haykin, Van Veen, Signals and Systems, 2nd Edition, Wiley, 200 6. Richard G. Lyons, 'Understanding Digital Signal Processing', Pearson, 2022 7. S. Palani, 'Signals and Systems', Springer International Publishing, 2021 8. Jivan Parab et al., Exploring C for microcontroller (Springer 2007) 			
Web Resources:	https://www.cadence.com			

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Discipline Specific Elective Courses

Title of the Course	EDA Tools	
Course Code	ELE-5201	
Number of Credits	02 (2T)	
Theory/Practical	Theory	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Familiarize the students with industry-oriented EDA tools. • Each Quartus, ISE compilations and programming and its use for design and analysis. • Enable the student to extract various design parameters from simulation results. 	
Course Outcomes:	The students will,	Mapped to PSO
	CO 1. Understand the EDA workflow for ASIC and FPGA design.	PSO 1
	CO 2. Learn to model digital systems using HDL (VHDL).	PSO 2

	CO 3. Analyse logic using Chip scope		PSO 4
	CO 4. Perform simulation, synthesis, place & route, and timing analysis		PSO2
	CO 5. Use EDA tools such as Xilinx Altera wave Analysis ,Modelsim tools.		PSO 1
	CO 6. Gain experience in RTL design and testbench development.		PSO 2
Content:		No of hours	Mapped to CO Cognitive Level
Module 1: EDA and HDL basics	1.1 Introduction to EDA & VLSI Design Flow	3	CO1 K1
	1.2 HDL coding basics	8	CO2 K2
	1.3 HDL Modeling Styles: Dataflow, Behavioural, Structural	2	CO2 K2
Module 2: EDA Tools	2.1 Introduction to lab tools and environment setup	7	CO5 K2
	2.2 Introduction Quartus and ISE webpack, Model sim, Chip scope	10	CO3 K2, K3
Pedagogy:	Lectures/Experiential Learning/Presentations		
Texts:	<ol style="list-style-type: none"> 1. Design through Verilog HDL By T. R. Padmanabhan & Sundari. IEEE press, Wiley Interscience. 2. Electronic Design Automation: Synthesis, Verification, and Test (Systems on Silicon) 26 March 2009 3. Hands on experience on alteradevelopment board by J.S.Parab,etal: Springer Netherland. 2018(ISBN 978-81-322-3769-3) 		
References/ Readings:	http://www.xilinx.com/itp/xilinx7/help/iseguide/html/ise_fpga_design_flow_overview.htm		

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Title of the Course	EDA Tools I
Course Code	ELE-5202
Number of Credits	02 (2P)
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Familiarize the students with industry-oriented EDA tools. • Each Quartus, ISE compilations and programming and its use for design and analysis. • Enable the student to extract various design parameters from simulation results. 	
Course Outcomes:	The students will be experiential hand-on on following.	Mapped to PSO
	CO 1. Understand the EDA workflow for ASIC and FPGA design.	PSO 1
	CO 2. Learn to model digital systems using HDL (VHDL).	PSO 2
	CO 3. Analyse logic using Chip scope	PSO 4

	CO 4. Perform simulation, synthesis, place & route, and timing analysis		PSO2
	CO 5. Use EDA tools such as Xilinx Altera wave Analysis ,Modelsim tools.		PSO 1
	CO 6. Gain experience in RTL design and testbench development.		PSO 2
Content:		No of hours	Mapped to CO Cognitive Level
Module 1: Practical	1.1 Study of Phases of Quartus compilations. 1.2 Study of phases of ISE compilations 1.3 Testing logic using ChipScope-I. 1.4 Testing logic using ChipScope-II 1.5 FIFO implementation 1.6 Pulse stretcher 1.7 Test bench using Modelsim-I 1.8 Test bench using Modelsim-I	60	CO3, CO6 K2, K3, K4, K5, K6
Pedagogy:	Lectures/Experiential Learning/Presentations /laboratory design and implementation		
Texts:	1. Design through Verilog HDL By T. R. Padmanabhan & Sundari. IEEE press, Wiley Interscience. 2. Electronic Design Automation: Synthesis, Verification, and Test (Systems on Silicon) 26 March 2009 3. Hands on experience on alter a development board by J.S.Parab,etal: Springer Netherland. 2018(ISBN 978-81-322-3769-3)		
References/ Readings:	http://www.xilinx.com/itp/xilinx7/help/iseguide/html/ise_fpga_design_flow_overview.htm		

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Title of the Course	Numerical Computation and Algorithms
Course Code	ELE-5203
Number of Credits	02 (2T)
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Students should have a knowledge of computer programming	
Course Objectives:	The course is intended to <ul style="list-style-type: none"> • Develop the basic understanding of numerical computation and algorithm. • Develop skills to implement algorithms to solve mathematical problems on the computer. • To provide basic knowledge of data structure. 	
Course Outcomes:	Students will be	Mapped to PSO
	CO 1. Student will understand basics of programming language	PSO4
	CO 2. The students will use data structures like Lists, Stack, Queue, and Binary Trees.	PSO4
	CO 3. The students will solve a linear system of equations using an appropriate numerical method.	PSO4

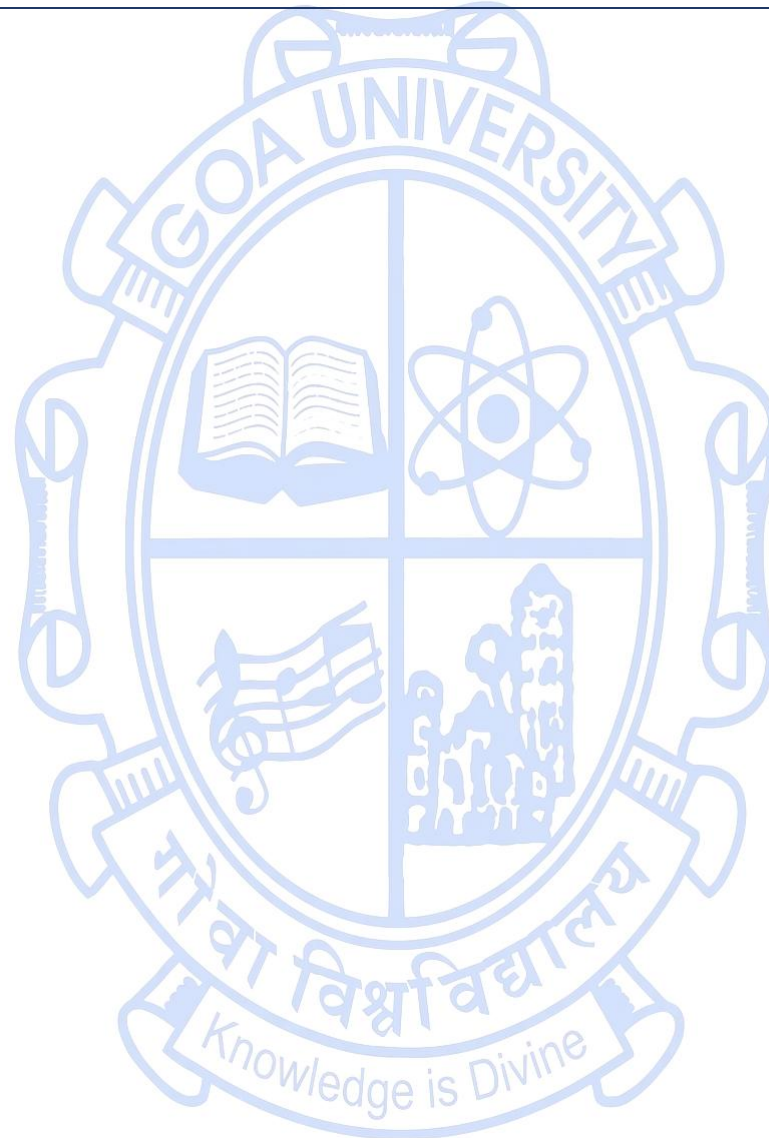
	CO 4. The students will use numerical methods for solving a problem, locate and use good mathematical software to achieve the required accuracy for a particular application, get the accuracy you need from the computer, assess the reliability of the numerical results.		PSO4	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Computer Programming	Introduction to Algorithms, Elements of Computer Programming language, Basics of algorithm design, general model.	6	CO1	K1, K2
Module 2: Data Structures	Introduction to Data Structures, Vectors and Lists, Stack, Queue, Binary Trees.	6	CO2	K1, K2
Module 3: Theory of Numerical programming	Numerical Integration: Theory of numerical errors, Trapezoidal & Simpsons rule, Romberg method, Improper integrals. Numerical Solution of linear equations: Gauss-Jordon elimination. Numerical Solutions of nonlinear equations: Bracketing, bisection, Secant, Regula falsi & Newton Raphson method. Numerical Solutions to Ordinary differential equations: Runge-Kutta method, Modified midpoint method.	18	CO3, CO4	K2, K3, K5
Pedagogy:	Lectures/Experiential Learning			
Texts:	<ol style="list-style-type: none"> 1. Data structures using C and C++ by Yedidyah Langsam, Moshe J Augenstein, Aaron M Tenenbaum, Prentice Hall of India, 1995 2. Numerical Recipes in C, William H. Press, Brain P. Flannery, William T. Vetterling, Saul A. Teulosky, Cambridge University Press, 1990. 			
References/ Readings:	<ol style="list-style-type: none"> 1. Data Abstraction and Problem solving in Java by Frank M Carrano, Janet J Prichard ,Addison-Wesley, 2001. 2. Numerical Mathematical Analysis, J. B. Scarborough, Oxford and IBM Publishing Company (1979). 3. Numerical Recipes in C: The Art of Scientific Computing by William H Press, Brian P Flannery, Saul A Teukolsky - Mathematics – 1992. 			

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Title of the Course	Numerical Computation and Algorithms Lab
Course Code	ELE-5204
Number of Credits	02 (2P)
Theory/Practical	Practical
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Students should have a knowledge of computer programming	
Course Objectives:	The course is intended to <ul style="list-style-type: none"> • Develop the basic understanding of numerical computation and algorithm. • Develop skills to implement algorithms to solve mathematical problems on the computer. • To provide basic knowledge of data structure. 	
Course Outcomes:	Students will be given hand-on with the following topics	Mapped to PSO
	CO 1. Student will understand basics of programming language	PSO4
	CO 2. The students will use data structures like Lists, Stack, Queue, and Binary Trees.	PSO4
	CO 3. The students will solve a linear system of equations using an appropriate numerical method.	PSO4

	CO 4. The students will use numerical methods for solving a problem, locate and use good mathematical software to achieve the required accuracy for a particular application, get the accuracy you need from the computer, assess the reliability of the numerical results.		PSO4	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practicals	<ol style="list-style-type: none"> 1. Push and pop operation on stack 2. Insert and delete operation on queue 3. Insertion and deletion operation on linked list 4. Traversing a binary tree 5. Read two 3X3 matrix, add them and display their sum 6. Numerical Programming 1 (Trapezoid method) 7. Numerical Programming 2 (Simposons 1/3 method) 8. Numerical Programming 2 (Bisection method) 9. Numerical Programming 6 (Gauss-Jordon elimination method) 10. Numerical Programming 3 (RungeKutta method) 11. Numerical Programming 4 (Newton Raphson method) 12. Numerical Programming 5 (Regula Falsi method) 13. Numerical Programming 6 (Secant method) 	60	CO1, CO4	K2, K5
Pedagogy:	Experiential Learning			
Texts:	<ol style="list-style-type: none"> 1. Data structures using C and C++ by Yedidyah Langsam, Moshe J Augenstein, Aaron M Tenenbaum, Prentice Hall of India, 1995 2. Numerical Recipes in C, William H. Press, Brain P. Flannery, William T. Vetterling, Saul A. Teulosky, Cambridge University Press, 1990. 			
References/ Readings:	<ol style="list-style-type: none"> 1. Data Abstraction and Problem solving in Java by Frank M Carrano, Janet J Prichard ,Addison-Wesley, 2001. 2. Numerical Mathematical Analysis, J. B. Scarborough, Oxford and IBM Publishing Company (1979). 3. Numerical Recipes in C: The Art of Scientific Computing by William H Press, Brian P Flannery, Saul A Teukolsky - 			



SEMESTER II

Discipline Specific Core Courses

Title of the Course	Advanced Digital Communication Systems	
Course Code	ELE-5004	
Number of Credits	04	
Theory/Practical	Theory	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	NIL	
Course Objectives:	This course is intended to: <ul style="list-style-type: none">• Introduce to students with basics of wireless systems – concepts, theory.• Covers various modulation techniques, to enable the student to synthesize and• Analyse wireless and mobile cellular communication systems over a stochastic fading channel• Mitigation and diversity techniques	
Course Outcomes:	Students will be	Mapped to PSO

	CO 1. understand the design, specifications and the performances of various wireless communication systems.		PSO 1	
	CO 2. Apply the cellular concepts to evaluate the signal reception performance in a cellular network.		PSO 4	
	CO 3. Apply the traffic analysis to design cellular network with given quality of service constraints.		PSO 3	
	CO 4. Determine the appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium.		PSO 2	
	CO 5. Analyze and design receiver and transmitter diversity techniques.		PSO2, PSO 4	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction to Mobile and Cellular Communication Systems:	Definitions, impact of Mobile and Cellular Radio Communication Historical overview. Fundamental of Radio Mobile and Cellular Practices Radio mobile links and cells, Frequency re-use, Principles of Cellular Com. Mobile Telephone Switching Subsystem, The mobile frequency spectrum, Hand-off, Cochannel and adjacent channel interference limitations, Near-far problem, Power Control.	5	CO1, CO2	K1, K2
Module 2: Mobile Communication Channel including antennas	The mobile wireless propagation channel, Notions on antennas especially the near and far field concept, Line of Sight (LOS) propagation, Multipath fading , outdoor and Indoor Propagation, Flat and selective fading, Special antennas for base stations and headsets, Deterministic, Empirical and Statistical Methods for propagation link computations.	10	CO1, CO3, CO4	K2, K3
Module 3: Overview of Mobile and Cellular Radio Communication Modulation and Detection Techniques:	Analog modulations and detection: AM, FM, PM, ACSB, Hybrid and Digital modulation: PCM, ASK, FSK, QPSK, QAM, MSK, etc, Coherent and noncoherent detection, C/N, S/N, Eb/No and BER relations, Probability concepts, Mobile Radio links parameters.	15	CO1, CO2, CO4	K3, K4

Module 4: Overview of Multiple Accesses Techniques	Simplex, Duplex TDD and Time Division Duplex, Time division multiple access (TDMA) FDMA and OFDM, Code Division multiple access (CDMA), Hybrid multiple access, Management of voice, Data and Video (Multimedia) information.	12	CO1	K2
Module 5: Modern Digital Radio Systems	standards, proposals and comparisons GSM (Europe and all over the world) - TDMA, IS-54 (U.S.A.)- TDMA, IS-95 (U.S.A., Korea) CDMA-, PHS (Japan) - TDMA, Frequency Hopping (FH) (U.S.A.) - CDMA, PCS, PCS Cordless telephone 2nd generation (CT-2), Cellular digital packet data (CDPD), and Wireless LAN, New standard trends Edge, 3rd and 4th generation beginning, LTE	10	CO3, CO4	K2, K3, K4
Module 6: Mitigation Techniques for Mobile System	Overview of Natural and manmade external noise sources, Radiation hazards effects from base stations, Mobile and portable equipments.	04	CO1	K1, K2
Module 7: Diversity Techniques for Mobile Radio Systems	Dispersive channels, Space diversity, Frequency diversity, Equalizer techniques	04	CO4	K2, K3
Pedagogy:	Lectures/Experiential Learning			
Texts:	Rappaport, T.S., "Wireless Communications: Principles And Practice, 2/E, Pearson			
References/ Readings:	<ol style="list-style-type: none"> 1. Steele, R., Hanzo, L., "Mobile Radio Communication" 3rd Edition Wiley 2005. 2. Wireless Communications (WIRELESS COMMUNICATIONS, 2ND ED, Molisch A F), Wiley 			

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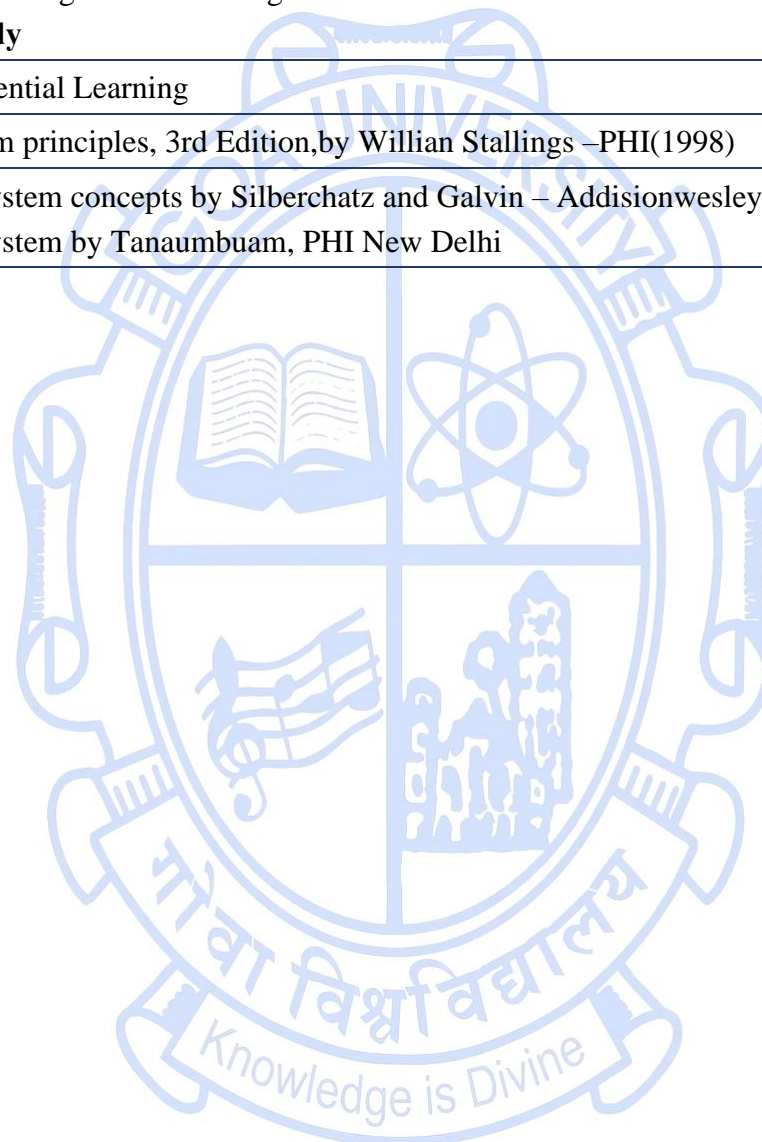
Title of the Course	Real Time Operating Systems
Course Code	ELE-5005
Number of Credits	04
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • To focus on the concept of highlighting the various methods of improvising speed of computing machine through the operating system organization and various entity managements. • To analyse the small embedded system developments through the Real Time Operating Systems for task management efficiency. • Porting RTOS on embedded platform 	
Course Outcomes:	The student will:	Mapped to PSO
	CO 1. Generalize the understanding of the computing machine and various entities associated with the enhancement of the efficiency.	PSO 1
	CO 2. Handle the operating system management process, memory, I/O, Secondary Disk and	PSO 4

	organizations of various.			
	CO 3. Handle any operating system for process and task management if follows the documentations of the same.			PSO 5
	CO 4. able to design any real time application using RTOS			PSO 5
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	<p>Introduction to Computer Organization and Architecture: hardware vs. software -the virtual machine concept, the concept of von Neumann architecture, hardware components and functions, trends in hardware development, system configurations and classifications.</p> <p>The Central Processing Unit: CPU components, register sets, instruction cycles, addressing modes, instruction sets, the concept of micro-programming, Basics of RISC approach, pipelined and super-scalar approaches, vector processors and parallel processors, hardware support for the OS.</p>	15	CO1, CO2	K1, K2
Module 2:	<p>Process Description and Control:Processes, process states, processor modes, context switching, CPU scheduling algorithms, threads</p> <p>Concurrency Control: Concurrent processes, critical section problem and solutions, mutual exclusion solution requirements, semaphores and monitors.</p>	15	CO2, CO3	K2, K3, K4
Module 3:	<p>Deadlocks:Characterization, detection and recovery, avoidance, prevention</p> <p>Inter Process Communication:classical IPC problems and solutions, IPC techniques.</p> <p>The Memory Subsystem: Memory types and hierarchy, module level Organization, cache memory. Memory partitioning, swapping, paging, segmentation, virtual memory.</p>	15	CO1, CO2, CO3	K1, K2, K3 K4
Module 4:	The Input/Output and File Subsystem:I/O devices, controllers and channels, bus structures, I/O techniques (programmed, interrupt-driven and DMA), I/O subsystem layers. Concepts of files and directories, issues and techniques for efficient storage and access of data. I/O and file system support for graphics, multimedia, databases,	15	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6

	transaction processing and networking. μCOS case study			
Pedagogy:	Lectures/Experiential Learning			
Texts:	Operating system principles, 3rd Edition, by Willian Stallings –PHI(1998)			
References/ Readings:	<ol style="list-style-type: none"> 1. Operating system concepts by Silberchatz and Galvin – Addisonwesley 2. Operating system by Tanaumbam, PHI New Delhi 			

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Title of the Course	Digital System Designs
Course Code	ELE-5006
Number of Credits	04
Theory/Practical	Theory
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Should have studied digital electronics at the graduate level	
Course Objectives:	This course is intended to, <ul style="list-style-type: none"> • Teach principles of combination and sequential logic design • Develop implementation skills using hardware description languages. • Teach and familiarize with industry technologies such as Memory, CPLDS, FPGA. 	
Course Outcomes:	Students will be learning theory of following.	Mapped to PSO
	CO 1. Understand number system, number system conversion, error detection techniques, Boolean algebra and basic logic gates.	PSO 2
	CO 2. Leverage Hardware description languages for realization of combinational and sequential designs	PSO 2

	CO 3. Understand principles of combination and sequential logic design		PSO 2	
	CO 4. Understand the different memories used in computer, programmable logic devices		PSO 2	
	CO 5. Understand the architecture of field programmable gate array, deployment of neural network on FPGA		PSO 3	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction	About Digital Design, Analog versus Digital, Electronic Aspects of Digital Design, PLD's, ASIC, Digital Design level. Digital Concept and Number System: General Positional number system conversions, Operation, BCD, Gray Code, Character Codes, Codes for Actions, Conditions, and States nCubes and Distance, Codes for Detecting and Correcting Errors, Error-Detecting Codes, Error-Correcting and Multiple Error-Detecting Codes, Hamming Codes, CRC Codes, Two Dimensional Codes, Checksum Codes, m-out-of-n Codes, Codes for Serial Data Transmission and Storage, Parallel and Serial Data, Serial Line Codes	6	CO1	K1, K2
Module 2: Combinational Logic Design Principles and practices	Switching Algebra, Combinational-Circuit Analysis, Combinational-Circuit Synthesis, and Timing Hazards, Documentation Standards, Circuit Timing, Combinational PLDs, Decoders, Encoders, Three-State Devices , Multiplexers, Exclusive-OR Gates and Parity Circuits , Comparators, Adders, Subtractors, and ALUs, Combinational Multipliers, Exclusive-OR Gates and Parity Circuits, Comparators, Adders, Subtractors, and ALUs , Combinational Multipliers.	8	CO1, CO3	K2, K3
Module 3: Hardware Description Languages	HDL-Based Digital Design, The VHDL Hardware Description Language, The Verilog Hardware Description Language	4	CO2	K2, K3
Module 4: Sequential Logic Design Principles & Practices	Bistable Elements, Latches and Flip-Flops, Clocked Synchronous State-Machine Analysis, Clocked Synchronous State-Machine Design, Designing State Machines Using State Diagrams, State-Machine Synthesis Using Transition Lists, Another State-Machine Design Example, Decomposing State Machines, Feedback Sequential-Circuit Analysis, Feedback Sequential-Circuit Design, Features, Sequential-Circuit	12	CO3	K2, K3, K4

	Design with VHDL, Sequential- Circuit Design with Verilog, Sequential-Circuit Documentation Standards, Latches and Flip-Flops, Sequential PLDs, Counters, Shift Registers, Iterative versus Sequential Circuits, Synchronous Design Methodology, Impediments to Synchronous Design ,Synchronizer Failure and Metastability			
Module 5: Memory, CPLDS	Read-Only Memory, Read/Write Memory, Static RAM, Dynamic RAM, Complex Programmable Logic Device	10	C04	K1, K2
Module 6: Field Programmable Gate Array	Introduction, FPGA Architectures, Configuration: SRAM-Based FPGAs and Antifuse Permanently Programmed FPGAs, Chip I/O, Circuit Design of FPGA Fabrics, Architecture of FPGA Fabrics, FPGA Soft-core Processor Development flow.	10	CO5	K2, K3
Module 7: Neural Networks on FPGA	Introduction, Designing a Neuron, Activation functions, Design of layers, Training and validations, Hardware verification, Case study using PYNQ/VITIS AI framework.	10	C05	K2, K3, K4
Pedagogy:	Lectures/Experiential Learning			
Texts:	Digital Design Principles and Practices, by John F. Wakerly, Prentice Hall's Fourth Edition.			
References/ Readings:	<ol style="list-style-type: none"> 1. Digital System Design using VHDL: Charles. H.Roth ; PWS (1998) 2. Scott Hauck and Andre DeHon , Reconfigurable Computing, Morgan Kaufmann, 2008 3. SrinivasDevadas, AbhijitGhosh, and Kurt Keutzer, “Logic Synthesis,” McGraw-Hill, USA,1994. 4. Neil Weste and K. Eshragian,”Principles of CMOS VLSI Design: A System Perspective,2ndedition, Pearson Education, 2000. 5. Kevin Skahill, “VHDL for Programmable Logic,” Pearson Education, 2000. M.N.O. Sadiku,Elements of Electromagnetics 2nd Edition) , Oxford University press, 1995 			

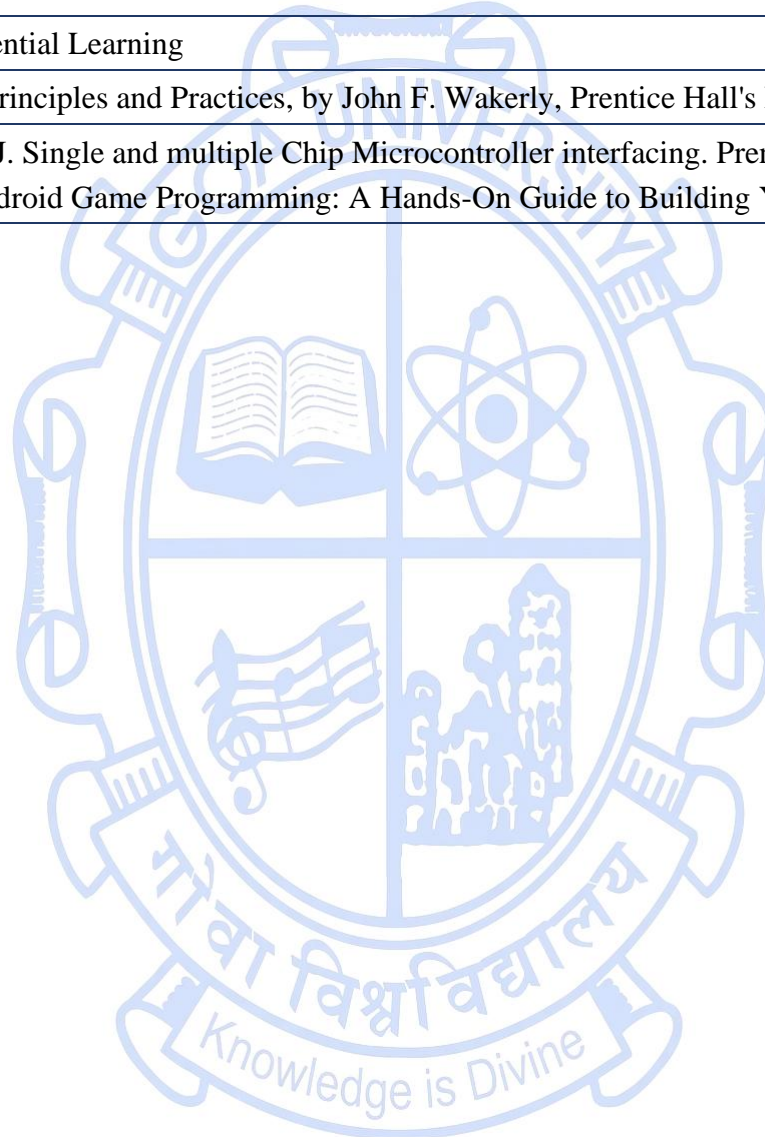
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Title of the Course	Electronics Practicals-II	
Course Code	ELE-5007	
Number of Credits	04	
Theory/Practical	Practical	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	Nil	
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Simulate the various digital modulation techniques and data correction and detection used in general communication systems. • Expose students to design digital circuits using HDL. • Cover experiments using LabVIEW with MyRIO and NI ELVIS Platform • Cover experiments using real time operating systems 	
Course Outcomes:	Students will be learning theory of following.	Mapped to PSO
	CO 1. Designs application using embedded system using tasks for real time applications.	PSO2
	CO 2. Handle any computing machine using shell script for computing and management.	PSO2

	CO 3. Develop and design some applications based on SPEEDY 33 using LABView, NI ELVIS ,MYRIO, Altera DE2 Board.		PSO5	
	CO 4. Develop an android app.		PSO5	
	CO 5. Design, simulate and debug digital circuits using HDL			
	CO 6. Implementation of the communication system for modulation, data coding, error coding channel coding methods.		PSO1, PSO2, PSO4	
Content:	Note: Minimum 4 experiments are to be performed from Each Module	No of hours	Mapped to CO	Cognitive Level
Module 1:	<ol style="list-style-type: none"> 1. ASK, FSK modulation & demodulation. 2. Implementation of MSK modulation and demodulation. 3. QPSK, modulation & demodulation DS-CDMA simulation. 4. Channel Coding methods. a. Convolution b. Block code 5. Error detection and correction Algorithm with CRC 6. Error detection and correction Algorithm with Hamming code 	40	CO1	K2, K2, K4
Module 2:	<ol style="list-style-type: none"> 1. Switching of LED using μ - COS 2. Switching of LED using RTX 3. Switching of LED using FPGA 4. KEY pad and ADC interfacing using RTOS 5. Shell programming – Web Application. 6. Shell programming – System Management 	40	CO2, CO3	K2, K3, K4, K6
Module 3:	<ol style="list-style-type: none"> 1. VHDL implementation for the Multiplexer & Demultiplexer 2. VHDL Implementation for Encoder & Decoder 3. VHDL implementation for the Counter. 4. LCD and 7 -segment Interfacing using DE2 board 5. UART Interface using DE2 board 	40	CO5	K3, K4, K5

	6. Echo & Reverberation implementation on speedy33 kit(lab view)			
Pedagogy:	Lectures/Experiential Learning			
Texts:	Digital Design Principles and Practices, by John F. Wakerly, Prentice Hall's Fourth Edition.			
References/ Readings:	<ol style="list-style-type: none"> 1. Lipovski G. J. Single and multiple Chip Microcontroller interfacing. Prentice Hall, USA 1998. 2. Learning Android Game Programming: A Hands-On Guide to Building Your First Android Game 1st Edition 			

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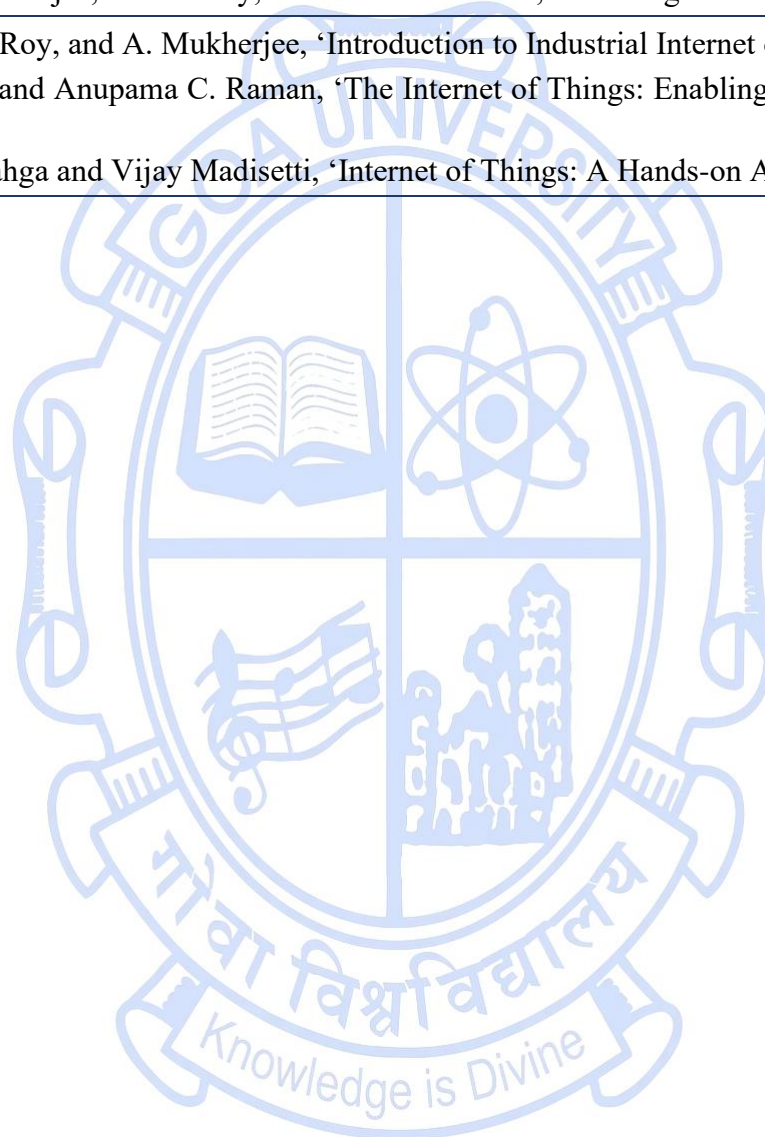
Discipline Specific Elective Courses

Title of the Course	Internet of Things (IOT)	
Course Code	ELE-5205	
Number of Credits	02	
Theory/Practical	2 Theory	
Level	400	
Effective from AY	2025-2026	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> Identify and define the fundamental concepts, terminologies, basic building blocks, characteristics, and applications of IOT. Understand the IOT protocols, cloud integration, and data communication methods Demonstrate the integration of sensors, actuators, and embedded technologies for IOT applications. Analyze and compare various network and communication technologies used in IOT. Design and develop IOT application for real-world problems. 	
Course Outcomes:	Students will be learning theory of following.	Mapped to PSO

	CO 1. Define key concept, components, and basic building blocks of IOT.		PSO 1	
	CO 2. Explain communication protocols and cloud integration in IOT systems.		PSO 1	
	CO 3. Implement basic IOT applications using embedded controllers, actuators, and sensors.		PSO 2	
	CO 4. Analyze network protocols for IOT applications.		PSO 4	
	CO 5. Design and build IOT solutions for applications like smart agriculture, smart irrigation.		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1.1 Introduction to IOT – Architecture, Applications of IOT in healthcare, industry, agriculture, and smart cities	04	CO1	K1, K2
	1.2 Embedded Systems and IOT Hardware – Overview of advanced ESP32, Raspberry Pi, and Arduino	06	CO1	K2
	1.3 Sensing, actuation, and interfacing	05	CO1	K1, K2
Module 2:	2.1 IOT Protocols and Communication - Connectivity Protocol (6LoWPAN, RFID), Data Protocol (MQTT, CoAP), Communication Protocols (IEEE 802.15.4, Zigbee, Bluetooth, Z-wave).	07	CO2	K1, K2
	2.2 Sensing Network - Wireless Sensor Network, Sensor nodes, Node behavior, Stationary and Mobile Wireless Sensor Network.	04	CO2	K1, K2
	2.3 Cloud and Fog Computing – Overview of cloud service model, and Fog Computing	04	CO2	K2
Pedagogy:	Lectures/Experiential Learning/Presentations			

Texts:	S. Misra, A. Mukherjee, and A. Roy, 'Introduction to IoT', Cambridge University Press, Edition First, 2021
References/ Readings:	<ol style="list-style-type: none"> 1. S. Misra, C. Roy, and A. Mukherjee, 'Introduction to Industrial Internet of Things and Industry 4.0', CRC Press. 2. Pethuru Raj and Anupama C. Raman, 'The Internet of Things: Enabling Technologies', Platforms, and Use Cases", CRC Press. 3. Arshdeep Bahga and Vijay Madisetti, 'Internet of Things: A Hands-on Approach', Universities Press

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Title of the Course	Internet of Things (IOT) Lab
Course Code	ELE-5206
Number of Credits	02
Theory/Practical	2 Practical
Level	400
Effective from AY	2025-2026
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Identify and define the fundamental concepts, terminologies, basic building blocks, characteristics, and applications of IOT. • Understand the IOT protocols, cloud integration, and data communication methods • Demonstrate the integration of sensors, actuators, and embedded technologies for IOT applications. • Analyze and compare various network and communication technologies used in IOT. • Design and develop IOT application for real-world problems. 	
Course Outcomes:	Students will be learning practicals of following.	Mapped to PSO
	CO 1. Define key concept, components, and basic building blocks of IOT.	PSO 1
	CO 2. Explain communication protocols and cloud integration in IOT systems.	PSO 1

	CO 3. Implement basic IOT applications using embedded controllers, actuators, and sensors.		PSO 2
	CO 4. Analyze network protocols for IOT applications.		PSO 4
	CO 5. Design and build IOT solutions for applications like smart agriculture, smart irrigation.		PSO 5
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Practicals based on IoT Device Interfacing, Communication, and Control (Any six)	30	CO3, CO4 K2, K3, K4
	1.1 Sensors (temperature, humidity, light, motion) interfacing with ESP 32 and Raspberry Pi		
	1.2 Actuators (relay, motor, buzzer) interfacing with ESP 32 and Raspberry Pi		
	1.3 Implementing client-server communication		
	1.4 Implementing REST API to fetch sensor data		
	1.5 Implementation of MQTT protocol		
	1.6 Task scheduling with RTOS for IOT		
	1.7 Remote monitoring and visualization of sensor data with platforms like Blynk/ThinkSpeak		
	1.8 Controlling the actuator by mobile app		
Module 2:	Practicals based on Wireless Protocols, Cloud Integration, and Smart Applications (Any Six)	30	CO3, CO4, CO5 K2, K3, K4, K5, K6
	2.1 Demonstration of Zigbee Communication Protocol		
	2.2 Send and visualize sensor data on cloud platform		

	2.3 Demonstrate wireless sensor network			
	2.4 Implementation of z-wave protocol			
	2.5 Home automation system			
	2.6 Smart lighting system			
	2.7 Smart Irrigation System			
	2.8 Implementation of Data Analytics for IoT			
Pedagogy:	Experiential Learning/Presentations			
Texts:	S. Misra, A. Mukherjee, and A. Roy, 'Introduction to IoT', Cambridge University Press, Edition First, 2021			
References/ Readings:	<ol style="list-style-type: none"> 1. S. Misra, C. Roy, and A. Mukherjee, 'Introduction to Industrial Internet of Things and Industry 4.0', CRC Press. 2. Pethuru Raj and Anupama C. Raman, 'The Internet of Things: Enabling Technologies', Platforms, and Use Cases", CRC Press. 3. Arshdeep Bahga and Vijay Madiseti, 'Internet of Things: A Hands-on Approach', Universities Press 			

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Title of the Course	Switching and Routing
Course Code	ELE-5207
Number of Credits	2
Theory/Practical	2T
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Introduce the student to the broader understanding of computer networks • Cover Extensive learning in switching and routing technologies. • Comprehensive understanding in LAN switching environment. 	
Course Outcomes:	Students will be learning theory of following	Mapped to PSO
	CO 1. Study the different network devices, topologies and protocols.	PSO5
	CO 2. Study of IP addressing and subnetting	PSO5
	CO 3. Gain the knowledge about the Switching and Routing	PSO5

	CO 4. Understand the basic device configuration and troubleshooting.		PSO5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Layered Architecture: Layered Architecture and protocols, Network Devices: Switches, Routers, NIC, Access Points, Modem. Network types: LAN, PAN, MAN & WAN, Topologies: Mesh Topology, Star Topology, Bus Topology, Ring Topology, Hybrid Topology. Network Addressing: IP addressing & Subnet, Classes of IP Addressing, IPv4/IPv6 address & Subnet	15	CO1, CO2	K1 K2
Module 2:	Routing Concepts: IP Routing, Types of Routing, Path Determination, Packet Forwarding, IP Routing Table, Dynamic Routing, Default Static Route Open Shortest Path First Concepts: OSPF Features and Characteristics, OSPF Packets, OSPF Operation Switching and Switches, Overview of VLANs, VLAN Configuration, VLAN Trunks, Dynamic Trunking Protocol, Inter VLAN routing, Spanning Tree Protocol	15	CO3, CO4	K1 K2
Pedagogy:	Lectures/Practicals/Experiential Learning/ FLIPPED CLASSROOM			
Texts:	CCNA Routing and Switching – Todd Lammle, 2nd Edition, Sybex Publisher (Wiley Brand), 2016.			
References/ Readings:	<ol style="list-style-type: none"> 1. Andrew S.Tanenbaum, 'Computer Networks', 3rd Edition, Prentice Hall. 2. Data Communications and Networking. Forouzan, 5th Edition, McGraw Hill, Reprint-2017. 3. James F. Kurose and Keith W. Ross, 'Computer Networking: A Top-Down Approach, 7th Edition, Pearson Education. 4. D-Link Certified, DCS Switching Training Guide. 			
Web Resources:	CISCO NETCAD (ONLINE ACCESS)			

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Title of the Course	Switching and Routing Lab
Course Code	ELE-5208
Number of Credits	2
Theory/Practical	2P
Level	400
Effective from AY	2025-2026
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	NIL	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Introduce the student to the broader understanding of computer networks • Cover Extensive learning in switching and routing technologies. • Comprehensive understanding in LAN switching environment. 	
Course Outcomes:	Students will be learning practicals of following	Mapped to PSO
	CO 1. Study the different network devices, topologies and protocols.	PSO5
	CO 2. Study of IP addressing and subnetting	PSO5
	CO 3. Gain the knowledge about the Switching and Routing	PSO5

	CO 4. Understand the basic device configuration and troubleshooting.		PSO5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practicals	<ol style="list-style-type: none"> 1. Study of Network Devices 2. Router Configuration: Configure Initial Router Settings, Configure Interfaces. 3. Router Configuration: Configure the Default Gateway, Ping and Traceroute. 4. DHCPv4 Configuration 5. DHCPv6 Configuration 6. Configure IP Default Static Routes 7. Open Shortest Path First Configuration 8. VLAN Configuration 9. Inter-VLAN routing Configuration 10. Spanning Tree Protocol Configuration 	60	CO1, CO2 CO3 CO4,	K3, K4
Pedagogy:	Practicals/Experiential Learning/ FLIPPED CLASSROOM			
Texts:	CCNA Routing and Switching – Todd Lammle, 2nd Edition, Sybex Publisher (Wiley Brand), 2016.			
References/ Readings:	<ol style="list-style-type: none"> 1. Andrew S.Tanenbaum, ‘Computer Networks’, 3rd Edition, Prentice Hall. 2. Data Communications and Networking. Forouzan,5th Edition, McGraw Hill, Reprint-2017. 3. James F. Kurose and Keith W. Ross, ‘Computer Networking: A Top-Down Approach, 7th Edition, Pearson Education. 4. D-Link Certified, DCS Switching Training Guide. 			
Web Resources:	CISCO NETCAD (ONLINE ACCESS)			

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SEMESTER III

Research Specific Elective (RSE) Courses

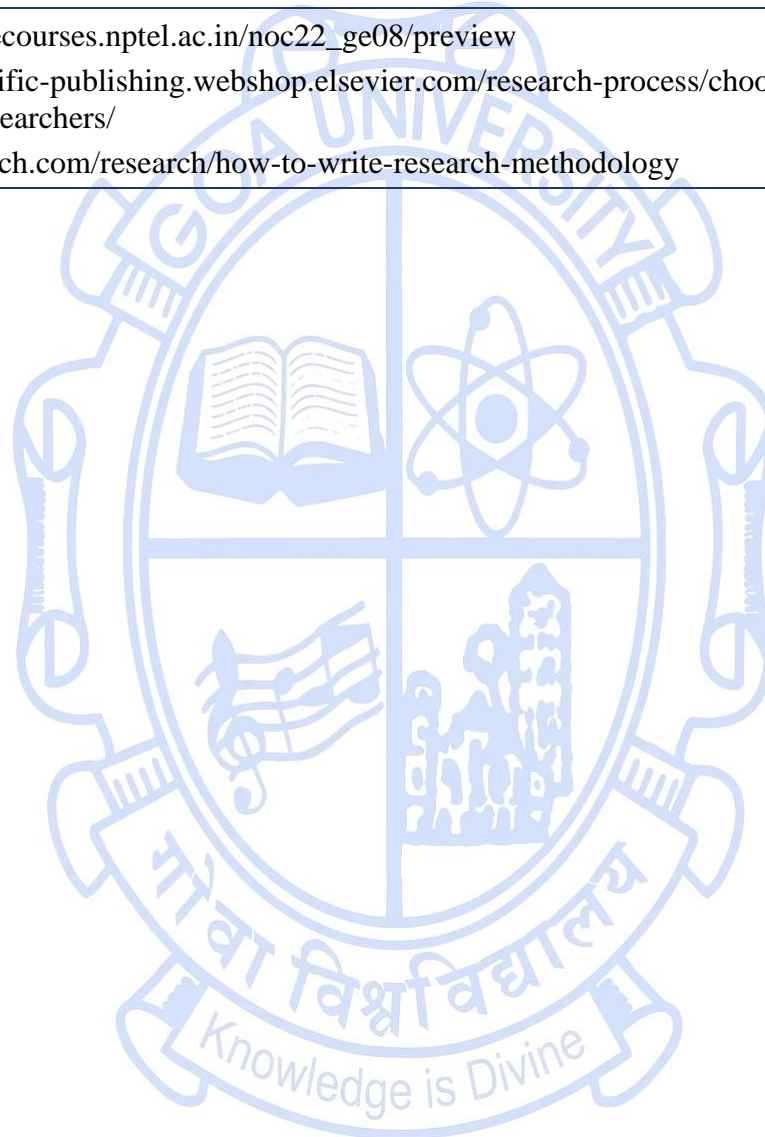
Title of the Course	Research Methodology
Course Code	ELE-6000
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No
Pre-requisites for the Course:	Nil
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none">• Introduce students to systematic research methods applicable to Electronics and allied fields.• Enable formulation of research problems and hypothesis relevant to electronics system design, signal processing, VLSI, embedded systems, Robotics , AI and communication technologies.• Familiarize students with modern data collection, analysis, Design and simulation tools.• Equip students with the ability to write technical papers, project proposals, and research reports.• Awareness of research ethics, intellectual property, and publication practices.

Course Outcomes:	CO 1. Understand the fundamental concepts, methods, and ethics of research in Electronics	Mapped to PSO		
	CO 2. Identify and formulate research problems relevant to electronics	PSO 1		
	CO 3. Design and conduct experiments, simulations, or analytical studies using modern tools.	PSO 2		
	CO 4. Interpret and evaluate data using statistical and computational techniques.	PSO 4		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction to Research	Meaning, Objectives, and Motivation of Research, Types of Research: Fundamental, Applied, Analytical, Descriptive, Qualitative, Quantitative. Research Process and Problem-Solving Approach in Engineering Identification of Research Areas in Electronics (Embedded system, Signal Processing, Communication, IoT, Sensors, VLSI, AI/ML in Electronics) Research Ethics and Integrity	7	CO1, CO2	K1,K2
Module 2: Research Problem Formulation and Design	Problem Identification and Statement Formulation, Literature Review using Digital Libraries (IEEE Xplore, ScienceDirect, SpringerLink, etc.) Research Design: Experimental Setup, Simulation Models, Case Studies Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches Hypothesis Development and Validation, Planning and Scheduling of Research Work	8	CO2	K2,K3
Module 3: Data Collection and Tools	Data Acquisition Systems in Electronics, Simulation Tools: MATLAB, Simulink, Multisim, Proteus, Cadence, Experimental Data Collection and Sensor Calibration, Sampling and Measurement	10	CO3	K3

	Errors, Data Logging, Signal Conditioning, and Filtering.			
Module 4: Data Analysis and Interpretation	Descriptive and Inferential Statistics in Research, Statistical Treatment of Analytical Data: Accuracy, Precision, Expressing accuracy & precision, Standard deviation, Types of errors, Elimination & minimization of errors, Significant figures, Criterion for the rejection of data (Q test), Student's t-test, Method of least squares for drawing the best fit line. Correlation, Regression, and ANOVA Applications, Optimization Techniques (Taguchi Method, DOE), AI/ML-based Data Analysis for Electronic Systems, Use of Tools: MATLAB, Python (NumPy, SciPy, Pandas), Origin.	10	CO4	K4, K5
Module 5: Technical Documentation and Research Ethics	Technical Report Writing: Dissertation, and Journal Articles Preparation of Abstracts, Graphs, Tables, and Figures. Referencing Styles (IEEE, APA) . Research ethics, Institutional ethics committee, Issues related to Plagiarism, Avoidance of Plagiarism and Academic Integrity, Abiding University Rules. Latex: Introduction to Latex, Installation of Latex, how to write application in Latex, how to write research paper in Latex, Use of Equations in Latex, Writing of Dissertation in Latex. Patent Search, Filing Process, and Intellectual Property Rights. Presentation of Research Work and Conference Participation.	10	CO5	K6
Pedagogy:	Lectures			
Texts:	1. C.R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques, New Age International, 4th Ed., 2019. 2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage, 2020.			
References/ Readings:	1. Douglas C. Montgomery, Design and Analysis of Experiments, Wiley, 9th Ed., 2020. 2. Creswell, J.W., Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Sage Publications, 2018.			

	3. Saunders, M., Lewis, P., & Thornhill, A., Research Methods for Business Students, Pearson, 8th Edition, 2019.
Web Resources:	<ol style="list-style-type: none">1. https://onlinecourses.nptel.ac.in/noc22_ge08/preview2. https://scientific-publishing.webshop.elsevier.com/research-process/choosing-the-right-research-methodology-a-guide-for-researchers/3. https://research.com/research/how-to-write-research-methodology

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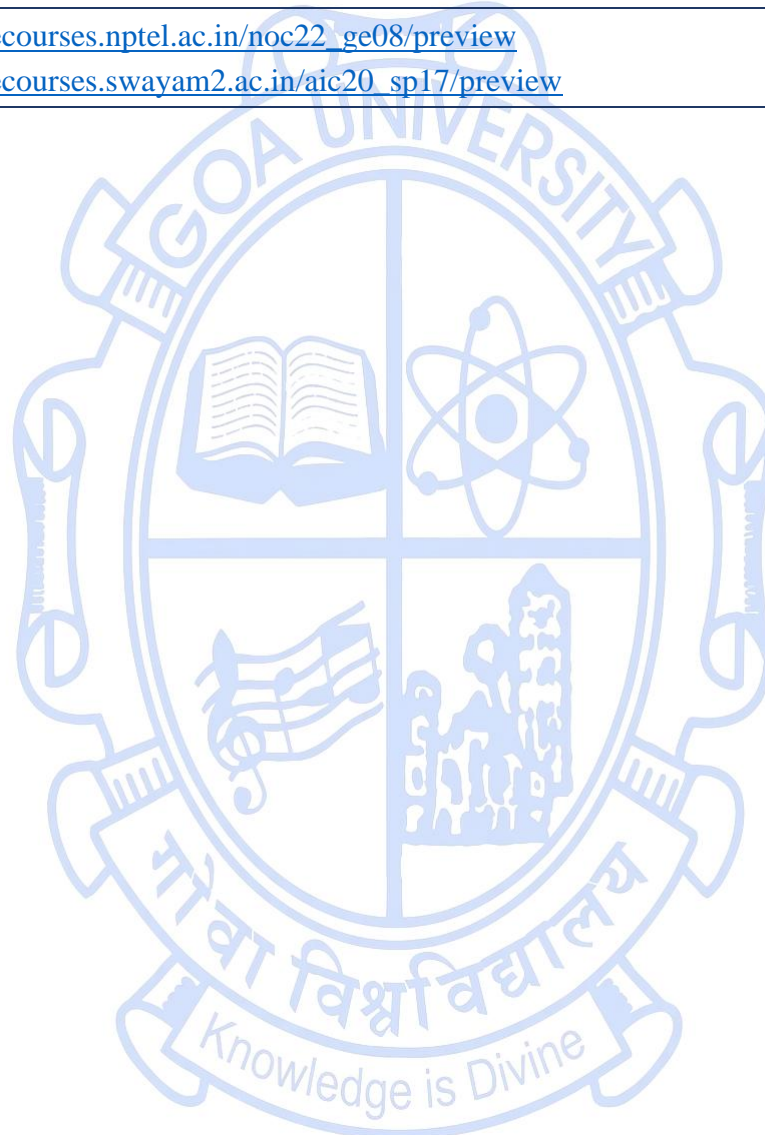
Title of the Course	Research Methodology Lab
Course Code	ELE-6001
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • To introduce students to fundamental research concepts including independent and dependent variables, hypothesis formulation, and experimental design. • To develop competency in data preprocessing, noise filtering, correlation, and regression analysis using MATLAB/Python. • To enable students to perform effective data analysis and visualization using scientific software tools • To train students in professional scientific documentation using LaTeX 	
Course Outcomes:		Mapped to PSO
	CO 1. Identify and differentiate independent and dependent variables, formulate appropriate hypotheses, and apply suitable hypothesis testing and validation techniques in research problems.	PSO 1

	CO 2. Implement noise filtering techniques and solve correlation and regression problems using MATLAB/Python to analyze experimental and real-world datasets.		PSO 1	
	CO 3. Analyze, interpret, and visualize experimental data effectively using Origin software to derive meaningful scientific conclusions.		PSO 2	
	CO 4. Interpret and evaluate data using statistical and computational techniques.		PSO 4	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practical	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> To study the concept of independent and dependent variables and understand their relationship in an experimental setup. To understand the process of formulating a hypothesis, types of hypotheses, and methods for testing and validating hypotheses in research. Implement Noise Filters using Matlab/Python Data Analysis using Origin Software Write Latex code to generate the table, insert an image in PNG and JPEG format into your document Using latex commands create a research article abstract. Correlation Problem using MATLAB/Python Regression Problem using MATLAB/Python 	30	CO1, CO2, CO3, CO4	K3,K4,K5
Pedagogy:	Experiential Learning			
Texts:	<ol style="list-style-type: none"> Wendy L. Martinez, Angel R. Martinez, Jeffrey Solka , Exploratory Data Analysis with MATLAB, CRC press ,3rd ed,2017 Charles K. Alexander & Matthew N.O. Sadiku, Fundamentals of Electric Circuits (for reference in data analysis and experiments), Mc Graw Hill,5Ed 2013 Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage, 2020. 			
References/	1. Douglas C. Montgomery, Design and Analysis of Experiments, Wiley, 9th Ed., 2020.			

Readings:	2. Palaniappan, Research Methodology for Engineers, PHI Learning, 2017.
Web Resources:	1. https://onlinecourses.nptel.ac.in/noc22_ge08/preview 2. https://onlinecourses.swyam2.ac.in/aic20_sp17/preview

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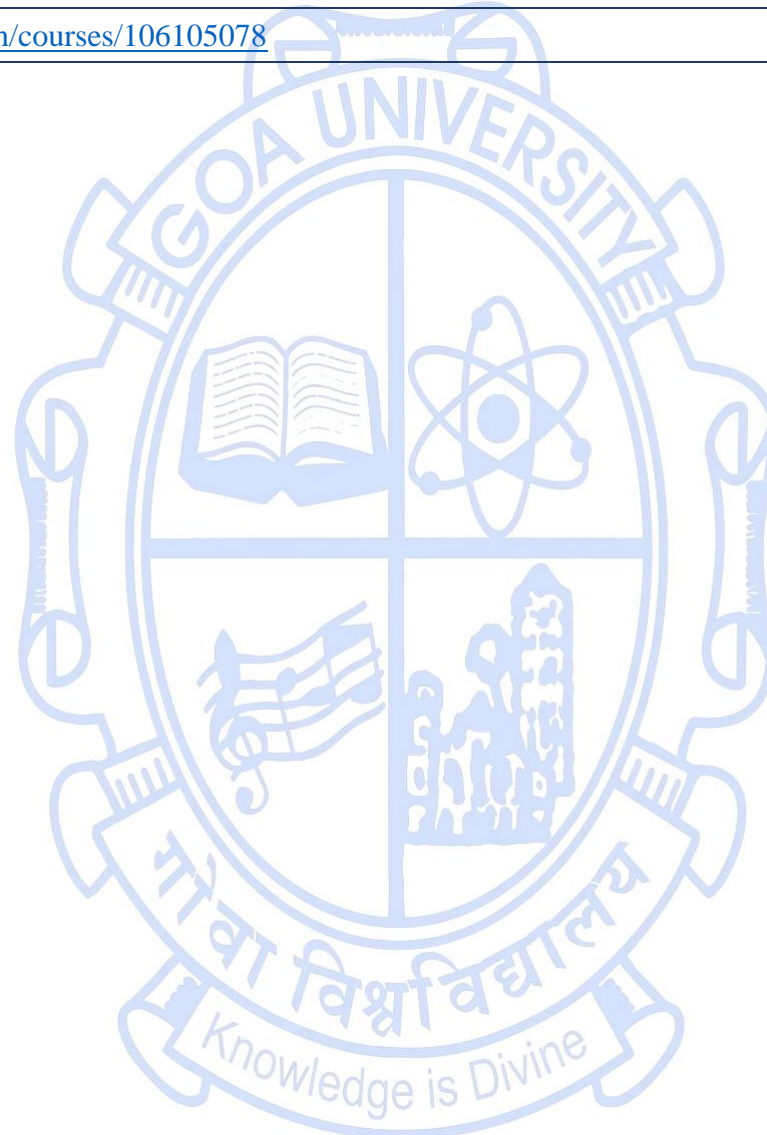
Title of the Course	Artificial Intelligence and Applications
Course Code	ELE-6002
Number of Credits	3
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	YES
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Introduce the foundation concepts in the field of artificial intelligence. • Become familiar with basic principles of AI toward problem solving • Know approaches of inference, perception, uncertain knowledge, and reasoning • Prepares a student to take a variety of focused, advanced courses in various subfields of AI. 	
Course Outcomes:		Mapped to PSO
	CO 1. Understand and apply the concepts of search algorithms in various applications	PSO 1
	CO 2. To Understand and apply the concepts of Knowledge in various applications	PSO 1
	CO 3. Apply, analyse and implement the concepts of Learning	PSO 3
	CO 4. Develop competency in utilizing neural networks in various applications	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction and search algorithms	History, Philosophy of AI, Definitions, AI System Hardware, AI accelerators, Types of accelerators (GPU, FPGA accelerators). Search: State space search(state, actions, transition model, goal test, path cost), Uninformed search, Depth-first search (DFS), breadth-first search (BFS), Informed search, Greedy best-first search, <i>A* algorithm, Adversarial Search, MinMax Algorithm</i>	10	CO1	K1,K2, K3,
Module 2: Knowledge and representation	Knowledge, Knowledge based agents, Propositional Logic: Connectives, Model, Knowledge base, Entailment, Inference, Model Checking, Knowledge Engineering, Inference Rules(Modus Ponens, And Elimination, Double negation Elimination, Implication Elimination, Bi conditional Elimination, De Morgan's Law, Distributive Property), Inference by resolution. First Order Logic: Universal <i>Quantification, Existential Quantification,</i>	10	CO2	K2, K3, K4,
Module 3: Learning	learning, supervised learning, classifications and regression, k- near neighbour, perceptron, support vector machine, loss function, over fitting and regularization, cross validation, reinforcement learning, Markov decision process, Q- learning, greedy decision making, function approximation, unsupervised learning, k means clustering.	10	CO3	K2, K3, K4, K5
Module 4: Neural Networks and applications of AI	Neural Network (NN), Artificial NN, Activation functions, gradient descent, Stochastic gradient Descent, Batch gradient Descent, Multi Layer neural network, Back Propagation, Deep Neural Network, Dropout, Image Convolution, Pooling, Convolution neural Network, Transfer Learning, Applications of AI: Computer Vision, agricultural and soil management applications, Health care, etc.	15	CO4	K3, K4, K5
Pedagogy:	Lectures/Experiential Learning			
Texts:	<ol style="list-style-type: none"> 1. <i>Alberto Artasanchez, Prateek Joshi, "Artificial Intelligence with Python", Packt Publishing, 2020.</i> 2. <i>Stuart J. Russell and Peter Norvig, 'Artificial Intelligence', Pearson, 3rd ED, 2016</i> 			
References/ Readings:	<ol style="list-style-type: none"> 1. <i>Deepak Khemani, 'A First Course in Artificial Intelligence', McGraw Hill Education (India), 1st ED, 2014.</i> 2. <i>George F Lugar, Artificial Intelligence: Structure and strategies for complex, Problem Solving, 6th ED, 2021.</i> 3. <i>Wolfgang Ertel, Nathanael T. Black, Introduction to Artificial Intelligence Nils J Nilsson, Springer,2018</i> 			

	4. <i>Principles of Artificial Intelligence, Illustrated Reprint Edition, Springer Heidelberg, 2014.</i>
Web Resources:	https://nptel.ac.in/courses/106105078

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Title of the Course	Artificial Intelligence and Applications Lab
Course Code	ELE-6003
Number of Credits	1
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	YES
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Present the foundation of artificial intelligence in a practical approach. • Hand on approach to impart the core AI principles. • Learn about different methods involved in classification and regression. • Introduce the concepts such as Transfer learning and character recognition 	
Course Outcomes:		Mapped to PSO
	1. Comprehend and use search techniques across different applications.	PSO 1
	2. To Understand and apply the concepts of Regression and classification	PSO 1
	3. Implement techniques such as clustering and convolution neural network.	PSO 3

	4. Develop competency in utilizing transfer learning and character recognition.		PSO 3	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practicals	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Implementation of Depth First Search 2. Implementation of Breadth First Search 3. Implementation of K- Nearest Neighbour for Regression on Spectral data 4. Implementation of K- Nearest Neighbour for Classification 5. Implementation of Support vector machine for Classification 6. Implementation of Support vector machine for Regression 7. Implementation of Clustering algorithm 8. Implementation of Convolution Neural Network 9. Implementation of Transfer Learning 10. Implementation of character recognition. 	30	CO1, CO2, CO3, CO4	K3, K4, K5, K6
Pedagogy:	Experiential Learning/Practical			
Texts:	<ol style="list-style-type: none"> 1. Alberto Artasanchez, Prateek Joshi, “Artificial Intelligence with Python”, Packt Publishing, 2020. 2. Stuart J. Russell and Peter Norvig, ‘Artificial Intelligence’, Pearson, 3rd ED, 2016 			
References/ Readings:	<ol style="list-style-type: none"> 1. Deepak Khemani, ‘A First Course in Artificial Intelligence’, McGraw Hill Education (India), 1st ED, 2014. 2. George F Lugar, Artificial Intelligence: Structure and strategies for complex, Problem Solving, 6th ED, 2021. 3. Wolfgang Ertel, Nathanael T. Black, Introduction to Artificial Intelligence Nils J Nilsson, Springer,2018 4. Principles of Artificial Intelligence, Illustrated Reprint Edition, Springer Heidelberg, 2014. 			
Web Resources:	https://nptel.ac.in/courses/106105078			

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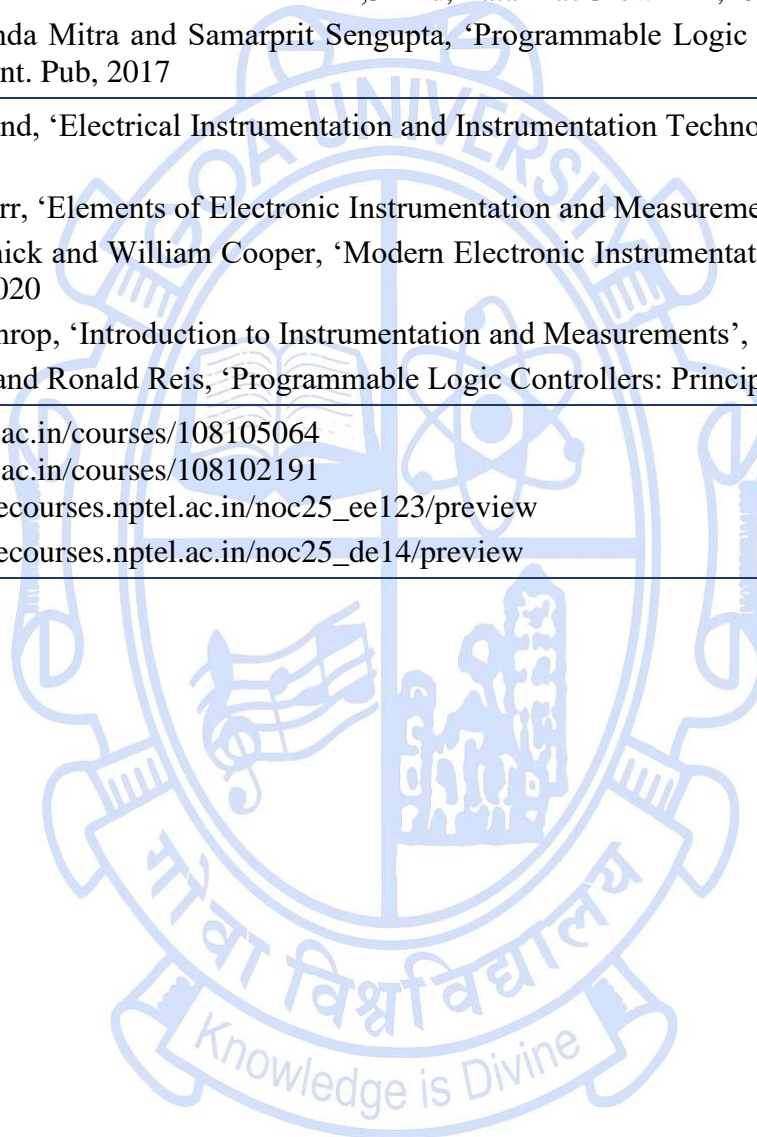
Title of the Course	Instrumentation & Control Theory
Course Code	ELE-6004
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Knowledge of analog and digital electronics, Basics of differential equations	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Impart foundational knowledge of measurement principles, transducers, and sensor technologies • Enable students to understand data acquisition techniques. • Familiarize students with signal conditioning components and methodologies • Develop knowledge of modern communication interfaces and protocols • Introduce control systems theory and PLC programming 	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Understand and explain the fundamental principles of measurement systems, transducers, and sensor technologies.	PSO 2
	CO 2. Comprehend the significance of signal conditioning and data acquisition techniques.	PSO 2

	CO 3. Gain the knowledge of various computer interfaces; understand the construction and working principle of different display devices and general-purpose equipment's used in signal analysis.		PSO 2	
	CO 4. Analyze the behavior of control systems and applications using PLCs		PSO 2, PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction	Basic Concepts of measurements, Calibrations and standards, Errors Transducers: Types and parameters, Sensors - Displacement, Strain, Vibration, Pressure, Flow, Temperature, Force and Torque etc.	06	CO1	K1,K2
Module 2: Data Acquisition & Signal Conditioning	Data Acquisition, Sampling and Storage: Fundamental concepts, Anti-aliasing, Multiplexers, Sample and Hold, Data Loggers Signal Conditioning: Introduction, Amplification, Instrumentation amplifier, Types of Filters	08	CO2	K1-K4, K6
Module 3: Communication Interfaces	Serial (RS-232), Parallel GPIB (IEEE-488), Universal Serial Bus (USB) and Variants, Ethernet, Bluetooth & Wi-Fi	08	CO3	K1-K2
Module 4: Display Devices & Test Equipment's	Display Devices: Review of CRT, LCD, Segmental and dot matrix displays, LED and its variants, MEMS display, Holographic Displays General Purpose Test Equipment's: CRO, Digital storage oscilloscope, Wave and Spectrum Analyzer, Pulse and waveform generators	08	CO3	K1-K2
Module 5: Control System	Types of control system - open loop, closed loop, linear, non-linear, continuous, discrete, frequency and time response, open loop motor control, Principles of PD, PI, PID	05	CO4	K1-K3
Module 6: Programmable Logic Controllers	PLC Fundamentals, Hardware details, switches, I/O, Power supply, CPU, Standards; Basics of Ladder programming, Sequential function charts, Function Block Diagram (FBD), Man- machine interface, Case studies.	10	CO4	K1-K3,K6
Pedagogy:	Lectures/Experiential Learning/Lab			

Texts:	<ol style="list-style-type: none"> 1. H. S. Kalsi, 'Electronic Instrumentation', 3rd Ed, Tata MacGrow-Hill, 2017 2. Madhuchhanda Mitra and Samarprit Sengupta, 'Programmable Logic Controllers and Industrial Automation', 2nd Ed, Penram Int. Pub, 2017
References/ Readings:	<ol style="list-style-type: none"> 1. M.M.S. Anand, 'Electrical Instrumentation and Instrumentation Technology', 1st ed, PHI Learning Private Ltd, New Delhi, 2020 2. Joseph J. Carr, 'Elements of Electronic Instrumentation and Measurement', 3rd Ed, Prentice Hall India, 2003 3. Albert Helfnick and William Cooper, 'Modern Electronic Instrumentation and Measurement Techniques', Prentice Hall India, 2020 4. Robert Northrop, 'Introduction to Instrumentation and Measurements', 3rd Ed, CRC Press, 2014 5. John Webb and Ronald Reis, 'Programmable Logic Controllers: Principles and Applications', 5th Ed, PHI, 2002
Web Resources:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/108105064 2. https://nptel.ac.in/courses/108102191 3. https://onlinecourses.nptel.ac.in/noc25_ee123/preview 4. https://onlinecourses.nptel.ac.in/noc25_de14/preview

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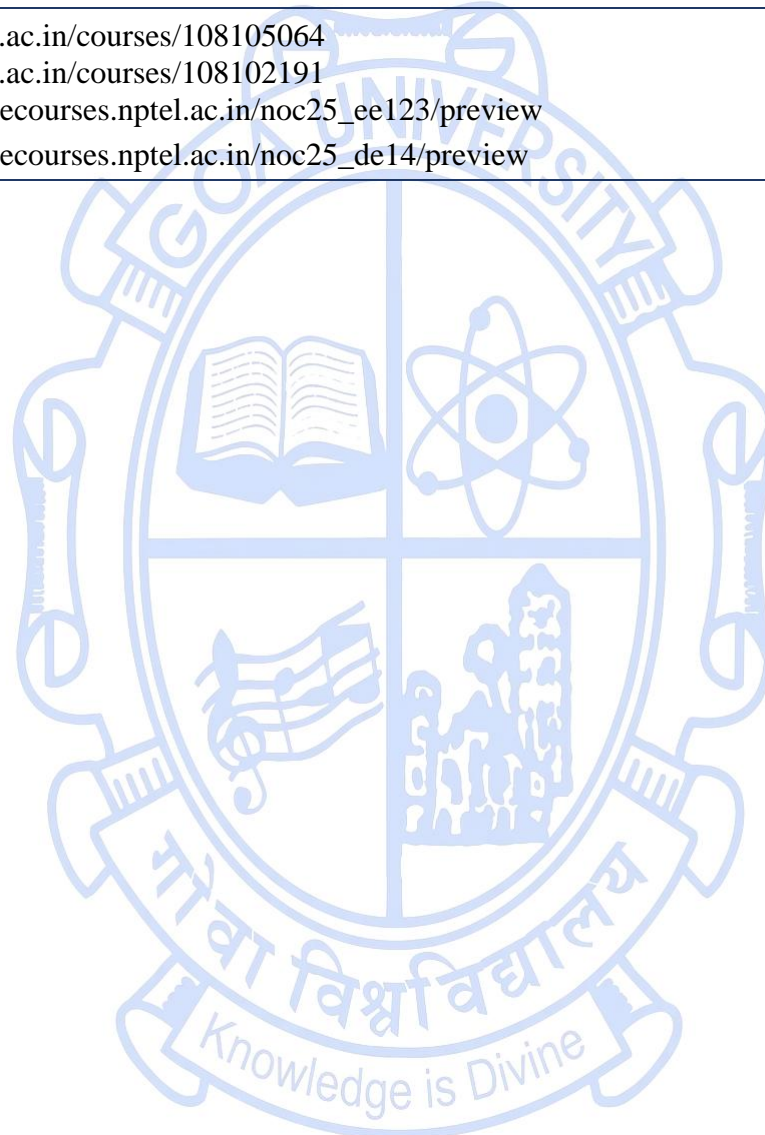
Title of the Course	Instrumentation & Control Theory Lab
Course Code	ELE-6005
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Knowledge of analog and digital electronics, Basics of differential equations	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Develop hardware implementation skills • Impart practical knowledge of measurement principles, transducers, and sensor technologies • Enable students to understand data acquisition systems & signal conditioning • Provide hands-on experience in control systems and PLC programming 	
Course Outcomes:	Students will be able to:	Mapped to PSO
	CO 1. Understand the fundamentals of transducers and sensor through hardware implementation.	PSO 2, PSO 5
	CO 2. Design and implement signal conditioning and data acquisition techniques.	PSO 2, PSO 5
	CO 3. Gain the knowledge of general-purpose equipment's used in signal analysis.	PSO 2, PSO 5

	CO 4. Design control systems and PLC based applications		PSO 2, PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practical's	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Design of variable voltage supply @ 2 Amps. 2. Design of Function Generator. 3. Design of Power Amplifier 10 Watts. 4. On-Off Temperature controller 5. Demonstrate effect of Sampling Rate and Aliasing 6. Acquire analog data (e.g., temperature/light intensity/etc) using a sensor and visualize it in real-time and Log data to a file. 7. PLC ladder program (logic functions/ De Morgan's Thm/etc.) 8. PLC FBD programming (logic functions/ De Morgan's Thm/etc.) 9. PLC based application using Ladder/FBD (automatic water tank level/ traffic light indication/etc.) 10. Design and tuning of PID controllers (P, PI, PID) in MATLAB 	30	CO1 - CO4	K2-K6
Pedagogy:	Lectures/Experiential Learning/Lab			
Texts:	<ol style="list-style-type: none"> 1. H. S. Kalsi, 'Electronic Instrumentation', 3rd Ed, Tata MacGrow-Hill, 2017 2. Madhuchhanda Mitra and Samarprit Sengupta, 'Programmable Logic Controllers and Industrial Automation', 2nd Ed, Penram Int. Pub, 2017 			
References/ Readings:	<ol style="list-style-type: none"> 1. M.M.S. Anand, 'Electrical Instrumentation and Instrumentation Technology', 1st ed, PHI Learning Private Ltd, New Delhi, 2020 2. Joseph J. Carr, 'Elements of Electronic Instrumentation and Measurement', 3rd Ed, Prentice Hall India, 2003 3. Albert Helfnick and William Cooper, 'Modern Electronic Instrumentation and Measurement Techniques', Prentice Hall India, 2020 4. Robert Northrop, 'Introduction to Instrumentation and Measurements', 3rd Ed CRC Press, 2014 			

	5. John Webb and Ronald Reis, 'Programmable Logic Controllers: Principles and Applications', 5 th Ed, PHI, 2002
Web Resources:	<ol style="list-style-type: none">1. https://nptel.ac.in/courses/1081050642. https://nptel.ac.in/courses/1081021913. https://onlinecourses.nptel.ac.in/noc25_ee123/preview4. https://onlinecourses.nptel.ac.in/noc25_de14/preview

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Title of the Course	Data Science and Machine Learning
Course Code	ELE-6006
Number of Credits	3T
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

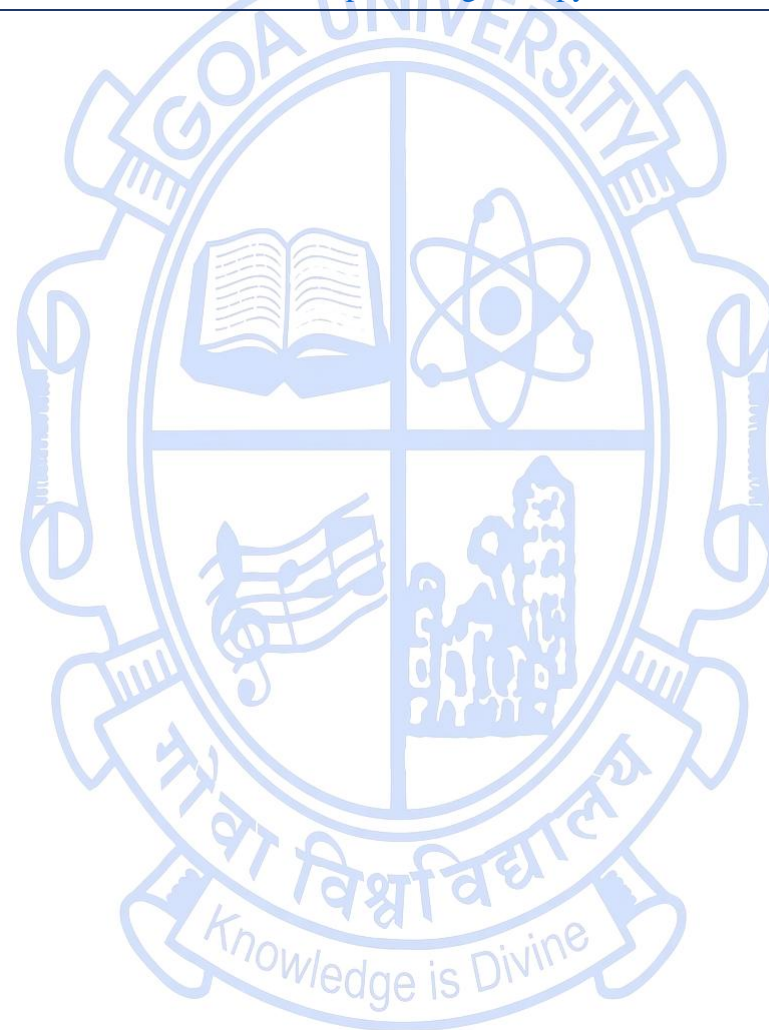
Pre-requisites for the Course:	Basic knowledge of linear algebra, statistics, probability, and familiarity with Python programming.	
Course Objectives:	<p>This course is intended to</p> <ul style="list-style-type: none"> • Introduce the mathematical foundations of machine learning. • Provide a conceptual understanding of supervised, unsupervised, and ensemble learning methods. • Describe the theoretical principles of neural networks and deep learning models. • Present advanced representation learning and generative modeling concepts. 	
Course Outcomes:		Mapped to PSO
	CO 1. Introduce core mathematical, statistical, and data science concepts for data analysis and dimensionality reduction.	PSO 1
	CO 2. Explain supervised and unsupervised machine learning techniques, along with appropriate performance evaluation metrics.	PSO 3

	CO 3. Understand the fundamental architectures and learning mechanisms of neural networks, including CNNs, RNNs, and their variants.		PSO 4	
	CO 4. Explain advanced deep learning and generative models and their applications.		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Foundations & Data Science Workflow	<p>Linear Algebra Basics: Vectors and vector operations, Matrices, Eigenvalues and eigenvectors, Singular Value Decomposition (SVD).</p> <p>Probability & statistics: Common probability distributions, Bayes Theorem, Maximum Likelihood Estimation (MLE), Hypothesis testing.</p> <p>Optimization: Gradient Descent, Stochastic Gradient Descent (SGD).</p> <p>Python overview for Data Science: NumPy, Pandas, Matplotlib.</p> <p>Data science workflow & Preprocessing: Exploratory Data Analysis (EDA), Data Preprocessing, Feature engineering.</p> <p>Dimensionality reduction: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA).</p>	15	CO1	K1, K2
Module 2: Machine Learning	<p>Supervised Learning - Regression: Linear Regression, Ridge, Lasso, Elastic Net, Evaluation metrics for regression.</p> <p>Supervised Learning - Classification: Logistic Regression, Decision Trees, Random Forest, Support Vector Machines (SVM), Evaluation matrices for classification.</p> <p>Ensemble methods: Bagging, Boosting.</p> <p>Unsupervised learning – Clustering: k-Means clustering, Hierarchical, Density-Based Spatial Clustering of Applications with Noise (DBSCAN).</p>	15	CO2	K1, K2
Module 3: Deep Learning & Advanced AI	<p>Neural Networks Basics: Perceptron, Activation functions, Backpropagation.</p> <p>Convolutional Neural Network (CNN): Convolution operation, Pooling layers, CNN architectures.</p>	15	CO3, CO4	K1, K2

	<p>Recurrent Neural Networks (RNNs) & Variants: RNNs, Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU).</p> <p>Advanced Deep Learning Models: Transformers, Bidirectional Encoder Representations from Transformers (BERT), Generative Pre-trained Transformer (GPT).</p> <p>Generative Models: Generative Adversarial Network (GAN), Variational Autoencoders (VAE), Diffusion Models.</p>			
Pedagogy:	Lectures/Experiential Learning			
Texts:	<ol style="list-style-type: none"> 1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, <i>Deep Learning</i>, 1st Edition, Cambridge, MA: MIT Press, 2016. 2. Aurélien Géron, <i>Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow</i>, 3rd Edition. Sebastopol, CA: O'Reilly Media, 2022. 3. Eli Stevens, Luca Antiga, and Thomas Viehmann, <i>Deep Learning with PyTorch</i>, 1st Edition, Shelter Island, NY: Manning, 2020. 4. Christopher Bishop – <i>Pattern Recognition and Machine Learning</i>, Springer 5. Christopher M. Bishop, <i>Pattern Recognition and Machine Learning</i>, 1st Edition, New York, NY: Springer, 2006. 			
References/Readings:	<ol style="list-style-type: none"> 1. Kevin Murphy, <i>Machine Learning: A Probabilistic Perspective</i>. Cambridge, MA: MIT Press, 2012. 2. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, <i>The Elements of Statistical Learning: Data Mining, Inference, and Prediction</i>, 2nd Edition. New York, NY: Springer, 2009 3. Tom Mitchell, <i>Machine Learning</i>, 1st Edition, New York, NY: McGraw-Hill Education, 1997. 4. A. Vaswani et al., "Attention is all you need," <i>Advances in Neural Information Processing Systems</i>, vol. 30, pp. 5998–6008, 2017. 5. M. Raghu, T. Unterthiner, S. Kornblith, C. Zhang, and A. Dosovitskiy, "Do vision transformers see like convolutional neural networks?" <i>Advances in Neural Information Processing Systems</i>, vol. 34, pp. 12116–12130, 2021 6. J. Ho, A. Jain, and P. Abbeel, "Denoising diffusion probabilistic models," <i>Advances in Neural Information Processing Systems</i>, vol. 33, pp. 6840–6851, 2020. 			
Web Resources:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106106139 			

2. <https://nptel.ac.in/courses/106106212>
3. https://www.learnpytorch.io/?utm_source=chatgpt.com
4. <https://pytorch.org/docs/stable/index.html>
5. https://365datascience.com/courses/deep-learning-with-pytorch/?utm_source=chatgpt.com

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Title of the Course	Data Science and Machine Learning Lab
Course Code	ELE-6007
Number of Credits	1P
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Basic knowledge of linear algebra, statistics, probability, and familiarity with Python programming.	
Course Objectives:	<p>This course is intended to</p> <ul style="list-style-type: none"> • Develop hands-on skills in applying mathematical foundations and optimization techniques for data analysis and model training. • Implement and evaluate core machine learning models for regression, classification, and clustering tasks. • Provide practical exposure to data preprocessing, feature engineering, and exploratory data analysis using real-world datasets. • Introduce practical implementation of neural networks and selected advanced AI models. 	
Course Outcomes:		Mapped to PSO
	CO 1. Apply vector, matrix, probability, and optimization techniques to prepare data and optimize machine learning models.	PSO 1

	CO 2. Perform data handling, feature engineering, and exploratory data analysis to extract meaningful insights from datasets.		PSO 3	
	CO 3. Implement and evaluate selected machine learning algorithms for regression, classification, ensemble learning, and clustering.		PSO 4	
	CO 4. Build and experiment with neural networks and selected deep learning models (CNN/RNN or Transformers/GANs) for practical data-driven problems.		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practicals	<p>(Note: Minimum 6 experiments are to be performed)</p> <p>Module 1: Foundations & Data Science Workflow (any two)</p> <ol style="list-style-type: none"> 1. Arrays & Vector Operations, Matrix Operations, Eigen decomposition , Singular Value Decomposition (SVD) 2. Probability & Bayes Theorem 3. Maximum Likelihood Estimation (MLE) & Hypothesis Testing 4. Gradient Descent & Stochastic Gradient Descent (SGD) 5. Data handling, Feature Engineering, & Exploratory Data Analysis (EDA) <p>Module 2: Machine Learning (any two)</p> <ol style="list-style-type: none"> 1. Regression Models 2. Classification Models 3. Ensemble Methods & Clustering <p>Module 3: Deep Learning & Advanced AI (any two)</p> <ol style="list-style-type: none"> 1. Neural Networks 2. Convolutional Neural Networks & Recurrent Neural Networks 3. Advanced Models – Explore Transformers or GANs on small datasets 	30	CO1, CO2, CO3, CO4	K3, K4, K5
Pedagogy:	Experiential Learning			

Texts:	<ol style="list-style-type: none"> 1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, <i>Deep Learning</i>, 1st Edition, Cambridge, MA: MIT Press, 2016. 2. Aurélien Géron, <i>Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow</i>, 3rd Edition. Sebastopol, CA: O'Reilly Media, 2022. 3. Eli Stevens, Luca Antiga, and Thomas Viehmann, <i>Deep Learning with PyTorch</i>, 1st Edition, Shelter Island, NY: Manning, 2020. 4. Christopher Bishop – <i>Pattern Recognition and Machine Learning</i>, Springer 5. Christopher M. Bishop, <i>Pattern Recognition and Machine Learning</i>, 1st Edition, New York, NY: Springer, 2006.
References/ Readings:	<ol style="list-style-type: none"> 1. Kevin Murphy, <i>Machine Learning: A Probabilistic Perspective</i>. Cambridge, MA: MIT Press, 2012. 2. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, <i>The Elements of Statistical Learning: Data Mining, Inference, and Prediction</i>, 2nd Edition. New York, NY: Springer, 2009 3. Tom Mitchell, <i>Machine Learning</i>, 1st Edition, New York, NY: McGraw-Hill Education, 1997. 4. A. Vaswani et al., "Attention is all you need," <i>Advances in Neural Information Processing Systems</i>, vol. 30, pp. 5998–6008, 2017. 5. M. Raghu, T. Unterthiner, S. Kornblith, C. Zhang, and A. Dosovitskiy, "Do vision transformers see like convolutional neural networks?" <i>Advances in Neural Information Processing Systems</i>, vol. 34, pp. 12116–12130, 2021 6. J. Ho, A. Jain, and P. Abbeel, "Denoising diffusion probabilistic models," <i>Advances in Neural Information Processing Systems</i>, vol. 33, pp. 6840–6851, 2020.
Web Resources:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106106139 2. https://nptel.ac.in/courses/106106212 3. https://www.learnpytorch.io/?utm_source=chatgpt.com 4. https://pytorch.org/docs/stable/index.html 5. https://365datascience.com/courses/deep-learning-with-pytorch/?utm_source=chatgpt.com

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Discipline Specific Vocational Elective (DSVE) Courses

Title of the Course	Laser System Engineering	
Course Code	ELE-6401	
Number of Credits	2T+2P	
Theory/Practical	Theory and practical	
Level	500	
Effective from AY	2026-2027	
New Course	Yes	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Teach the difference between ordinary light and light emitted by a laser device. • Introduce the method used for excitation of laser devices. • Explain the theory behind generation of stimulated emissions • Competence in application of the laser principles for design of various research and market application 	
Course Outcomes:		Mapped to PSO
	CO 1. Understand the fundamentals of lasers and difference between ordinary light and light emitted by a laser device.	PSO 6

	CO 2. To Understand Interaction of Radiation with Matter and Principle of Laser action		PSO 6	
	CO 3. To apply the concepts of laser resonator stability and to use it in its design.		PSO 5	
	CO 4. Application of the laser principles in design of various types of lasers and its applications		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Overview and Nature of Light	Overview of Lasers: History, Types and Applications of Lasers. Nature of Light: Corpuscular Theory, Wave Theory, Electromagnetic Spectrum, Quantum nature of light, Dual nature of nature. Matter: Structure of Atoms & Molecules. Energy Levels, Electronic, Vibrational and Rotational Energy Levels with Examples. Two-level representation	8	CO1	K1, K2, K3,
Module 2: Interaction of Radiation with Matter	Absorption, Spontaneous Emission, Stimulated Emission, Einstein's A & B Coefficients of Transitions, Maxwell Boltzmann Distribution, Planck's law of blackbody radiation. Principle of Laser action: Population inversion, metastable states, gain medium, Pumping mechanisms, feedback mechanism, threshold condition for laser beam generation	8	CO2	K2, K3, K4
Module 3: Optical resonators and characteristics of lasers	Optical Resonators: Types of Resonators, Stability Criteria, g-parameters. Characteristics of Laser Beams: Monochromaticity, Directionality, Brightness, Coherence: temporal & spatial.	6	CO3	K2, K3, K4, K5
Module 4: Types of lasers	Types of Lasers: Three-level and Four-level Lasers, Ruby, He-Ne, Nd:YAG, Carbon Dioxide Lasers, Semiconductor Lasers. Longitudinal & Transverse Modes, General, Industry, Defence, Medicine, Entertainment Applications of Lasers	8	CO4	K2, K3, K4
Module 5: Practicals	(Note: Minimum 10 experiments are to be performed) 1. Study of different components of LASER	60	CO1, CO2, CO3,	K3, K4, K5, K6

	2. Calculation of the beam parameters of LASER 3. Calculation of the wavelength of a LASER 4. Spatial coherence of a LASER 5. Temporal coherence of a LASER 6. Linearity of the semiconductor LASER 7. Comparison of Power efficiency of LASER 8. Comparison of diffraction of Normal and LASER light 9. Calculation of Brewster's angle using LASER 10. Verification of Malus Law using LASER 11. Verification of Beer Lamberts law using LASER 12. Study of Pumping Mechanism		CO4	
Pedagogy:	Lectures/Experiential Learning/Practicals			
Texts:	1. A. Yariv, "Optical Electronics", 4th Edition by, HRW publication, 1991. 2. A.Ghatak, 'Optical Electronics, 1 st Ed, Cambridge University Press, 2016			
References/Readings:	1. Lasers:Principles, Types and Applications ; Author, K. R. Nambiar ; Publisher, New Age International, 2006 ; 2. William T. Silfvast, "Laser fundamentals", 2nd , Cambridge University Press, 2008 3. K.Thyagarajan, and Ajoy Ghatak, Lasers: Fundamentals and Applications (Graduate Texts in Physics), Springer publication, 2012. 4. L. Tarasov, "Laser Physics and application" , Mir Publication, 1987			
Web Resources:	https://nptel.ac.in/courses/104104085			

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Title of the Course	Biometrics
Course Code	ELE-6402
Number of Credits	2T+2P
Theory/Practical	Theory + Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Mathematics Fundamentals, Signal Processing, Programming, and Machine Learning basics	
Course Objectives:	<p>This course is intended to</p> <ul style="list-style-type: none"> • Introduce biometric traits, image processing basics, and biometric system architecture. • Understand system performance metrics, security issues, and trade-offs in biometric systems. • Apply practical skills in image processing, feature extraction, and classification techniques for biometrics. • Analyze multimodal systems and address vulnerabilities in biometric applications. 	
Course Outcomes:		Mapped to PSO
	CO 1. Understand biometric system design, performance evaluation, and biometric modalities with their applications.	PSO 1
	CO 2. Explain multimodal biometric systems, security and privacy challenges, presentation attack, and relevant standards.	PSO 4

	CO 3. Implement feature extraction and classification techniques for fingerprint, face, iris, and voice recognition		PSO 3	
	CO 4. Evaluate vulnerabilities, spoofing, and multimodal strategies for biometric security		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Fundamentals of Biometrics	<p>Introduction to Biometric Systems: General overview of biometric systems, Design of biometric systems, Authentication vs. Identification, components of a biometric system.</p> <p>Performance analysis: False Acceptance Rate (FAR), False Rejection Rate (FRR), Equal Error Rate (EER), Receiver Operating Characteristics (ROC) curve, Detection Error Tradeoff (DET) curve, score distribution.</p> <p>Biological characteristics: Face, Fingerprint, Iris, Periocular. 4hours</p> <p>Behavioural characteristics: Keystroke dynamics, Gait, Signature, voice, Electroencephalogram (EEG).</p> <p>Comparison and Applications: Physiological vs behavioral properties, strengths, and weaknesses of each modality, applications of biometrics.</p>	15	CO1	K1, K2
Module 2: Multimodal Biometric Systems and Security	<p>Multimodal biometrics: Multimodal biometric system architecture, Fusion methods, Continuous biometric authentication, Biometric sample quality measure.</p> <p>Biometric system security: Vulnerabilities: Privacy issues and template protection, Encryption for biometrics, General Data Protection Regulation (GDPR), and ethical aspects.</p> <p>Spoofing and Presentation attacks: Attack types, Live detection techniques, and Standards for presentation attack detection. 3hours</p> <p>Biometric Standards and Applications: Biometric standards, Large-scale biometric system, Emerging applications.</p>	15	CO2	K1, K2
Module 3: Practicals	<p><i>Any Ten Experiments</i></p> <p>A: Fundamentals of Biometrics (Any seven)</p> <p>1. Image preprocessing</p>	60	CO3, CO4	K3, K4, K5

	<ol style="list-style-type: none"> 2. Convolution and filtering 3. Edge detection 4. Fingerprint Processing 5. Face detection and recognition 6. Iris segmentation and feature extraction 7. Voice recognition 8. EEG-based recognition <p><i>B: Multimodal Biometrics and Security (Any three)</i></p> <ol style="list-style-type: none"> 9. Performance evaluation 10. Multimodal biometric fusion 11. Vulnerability of biometric system 12. Presentation attacks detection 			
Pedagogy:	Lectures/Experiential Learning			
Texts:	<ol style="list-style-type: none"> 1. Anil Jain, Arun Ross, and Karthik Nandakumar, Introduction to Biometrics, 1st Edition, New York, NY: Springer, 2011. 2. Anil Jain, Patrick Flynn, and Arun Ross, Handbook of Biometrics, 2nd Edition, New York, NY: Springer, 2020. 			
References/ Readings:	<ol style="list-style-type: none"> 1. Nalini Ratha and Ruud Bolle, Automatic Fingerprint Recognition Systems, 1st Edition, New York, NY: Springer, 2003 2. John Daugman, "How iris recognition works," IEEE Transactions on Circuits and Systems for Video Technology, vol. 14, no. 1, pp. 21–30, Jan. 2004. 3. Stan Z. Li and Anil Jain, Encyclopedia of Biometrics, 2nd Edition. New York, NY: Springer, 2015. 			
Web Resources:	https://nptel.ac.in/courses/106104119			

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Title of the Course	Biomedical Instrumentation
Course Code	ELE-6403
Number of Credits	04 (2T+2P)
Theory/Practical	Theory + Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Should have studied basics of instrumentation and analog electronics at the graduate level	
Course Objectives:	<p>This course is intended to: ·</p> <ul style="list-style-type: none"> ● Introduce fundamentals of biomedical instrumentation and cardiovascular measurements ● Introduce non-invasive diagnostic imaging ● Cover noise reduction technique in electronics systems ● Provide fundamental knowledge of Clinical instrumentation ● Provide hands-on experience with design and working of various biomedical instrumentation systems. 	
Course Outcomes:	CO 1. Understand Fundamentals of medical instrumentation, Bioelectric potential, Electrodes and types of transducers	Mapped to PSO PSO 2
	CO 2. Understand the importance of Noise reduction technique in electronics systems	PSO 2

	CO 3. Understand Cardiovascular system and instruments used for diagnostic.		PSO 2	
	CO 4. Discuss non-invasive imaging system and clinical instrumentation		PSO 5	
	CO 5. Design and implement different amplifier circuits and measure various biomedical signals using appropriate tools.		PSO 2	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction to Biomedical Instrumentation	Components of Man-Measurement system, Physiological system of body, Basic transducer principle, Source of Bioelectric Potential, Skin contact Impedance, Electrodes: ECG, EEG, EMG, Microelectrodes.	7	CO1	K1, K2
Module 2: Noise reduction techniques in Electronics System	Introduction, cabling, grounding, balancing and filtering, shielding, contact protection, Active device Noise, and Electrostatic discharge.	8	CO2	K1, K2, K3
Module 3: Cardiovascular System	Heart and cardiovascular system, characteristics of blood flow, Electrocardiography, Measurement for Blood Pressure, Photo-plethysmography, and Functional NIR for brain oxygenation.	5	CO3	K2, K3
Module 4: Non-invasive diagnostic imaging	X-Ray, CT, MRI, fMRI, PET and SPECT, ULTRASOUND, Optical Tomography	7	C04	K3, K4
Module 5: Instrumentation for clinical laboratory	Blood, Test for Blood cells, chemical Tests, Automation of chemical Test	3	C04	K4
Module 6: Practicals	(Minimum 10 experiments are to be performed) 1. Blood pressure measurement using sphygmomanometer. 2. Design of differential amplifiers.	60	CO1- CO3, CO5	K1-K6

	<ol style="list-style-type: none"> 3. Design of Transimpedance amplifiers. 4. Low noise amplifiers. 5. Design of instrumentation amplifier. 6. Measurement PH using PH meter. 7. Study of types of electrodes. 8. Recording of ECG using ECG simulator. 9. Recording of EEG using EEG simulator. 10. Optical isolation Amplifier. 11. Experiments on Photo-plethysmography. 12. Recording of EMG using EMG simulator. 			
Pedagogy:	Lectures/Experiential Learning			
Texts:	R .S, Khandpur, “Handbook of Biomedical instrumentation”, Tata Mc GRAW Hill, 2014.			
References/ Readings:	<ol style="list-style-type: none"> 1. Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer, “Biomedical instrumentation and Measurements” Prentice Hall India, 2011. 2. Henry W. Ott, “Noise reduction Technique in Electronic systems” , Wiley & sons, 1998. 3. Paul Suetens, “Fundamentals Of Medical Imaging”, 3rd Edition, Cambridge University Press, 2017. 			
Web resources	https://nptel.ac.in/courses/102106669			

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SEMESTER IV

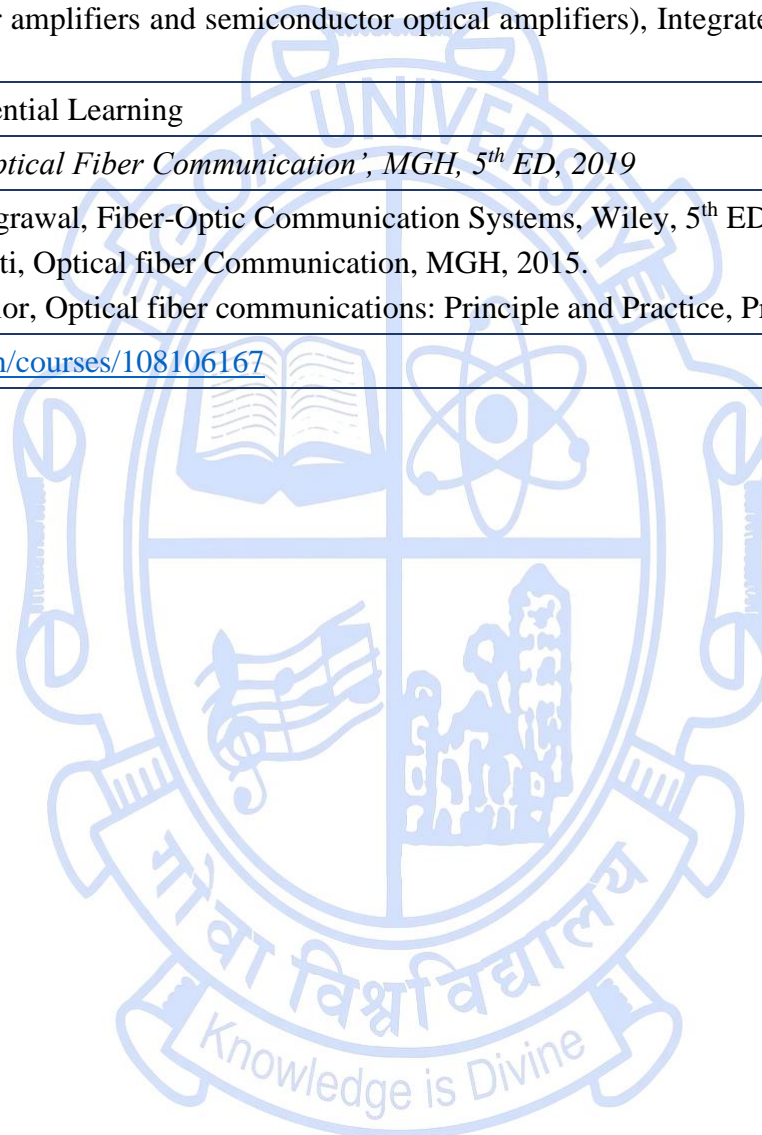
Generic Elective (GE) Courses

Title of the Course	Optical Communication Systems	
Course Code	ELE-6201	
Number of Credits	03	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-2027	
New Course	Yes	
Bridge Course/ Value added Course	No	
Course for advanced learners	Yes	
Pre-requisites for the Course:	Nil	
Course Objectives:	This course is intended to: <ul style="list-style-type: none">• Highlight the importance of optical communication over existing copper cable and microwave communication.• Create a strong theoretical base to understand the difference between the ray theory and wave theory approach for the passage of signals in optical fibers.• Discuss the estimation sources and detectors used in communication system.• Discuss different optical fiber characteristic and their manufacturing process.	
Course Outcomes:		Mapped to PSO

	CO 1. Understand the propagation of light inside optical fibers, fiber types, and fabrication of optical fibers.		PSO 6	
	CO 2. Light sources used in the optical communication system.		PSO 6	
	CO 3. Understanding of types of detectors and receiver circuit design in the communication system.		PSO 2	
	CO 4. Power budget calculation and advanced communication system.		PSO 2	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Light Propagation in Optical Fiber	Introduction & Evolution of Fiber optics system, Geometric picture, Pulse spread due to material dispersion, loss mechanism, Theory of Optical waveguides, methods of waveguides analyses, modes in steps and graded index fiber, new types of optical fibers.	9	CO1	K1-K2-K3
Module 2: Fiber Optics Technology	Fiber materials & fiber fabrication, cable design, coupling, splicing and connectors, splicing methods, connectors, fiber measurements. Signal Degradation: Attenuation, Losses, Distortion, and Pulse broadening.	8	CO1, CO3	K3-K4
Module 3: Optical Source and Power Launching	LED and LDs, development of Laser diodes structures, transmitter circuits, Coupling efficiency of the source to fiber. Source to fiber power launching, fiber joints, splicing.	8	CO2	K3-K4
Module 4: Optical Detector and Receiver Design	Photoconductive detector: biasing circuit, Commercial photoconductor, Heterodyne, Detection, p-n junction & its Equivalent circuit. Photodiode: Geometry of p-i-n, Frequency Response of Photodiodes/N ratio, Schottky photodiode. Avalanche diode: Construction, S/R ratio, minimum detection of power. Noise in detectors. Receiver design & configuration, Receiver operations, Error sources, Receiver noise	10	C03	K3-K4-K5
Module 5: Communication	System requirement, System design, Link analyses, Power budgeting, Line coding (NRZ, RZ, Block codes), TDM, Undersea fiber optics communication system, fibers in a	10	C04	K3-K4-

System Design and Advance System	telephone network, WDM, DWDM, OAE techniques, LAN topologies, Optical amplifiers (Fiber amplifiers and semiconductor optical amplifiers), Integrated optics and photonics.			K5
Pedagogy:	Lectures/Experiential Learning			
Texts:	<i>Gerd Keiser, 'Optical Fiber Communication', MGH, 5th ED, 2019</i>			
References/ Readings:	<ol style="list-style-type: none"> 1. Govind P. Agrawal, Fiber-Optic Communication Systems, Wiley, 5th ED, 2021. 2. P. Chakrabarti, Optical fiber Communication, MGH, 2015. 3. John M. Senior, Optical fiber communications: Principle and Practice, Prentice Hall, 2009. 			
Web resource	https://nptel.ac.in/courses/108106167			

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Title of the Course	Optical Communication Systems Lab
Course Code	ELE-6202
Number of Credits	1
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to: ·</p> <ul style="list-style-type: none"> • Introduce the fundamental working principles and structure of optical fibers, including key parameters like numerical aperture and v-number. • Familiarize with the practical techniques for coupling light into optical fibers and methods for characterizing various losses in the fiber. • Provide hands-on experience in characterizing essential components of an optical communication link, specifically sources and detectors. • Develop experimental skills to measure and analyze the performance characteristics of an optical communication system. 	
Course Outcomes:		Mapped to PSO
	CO 1. Determine and understand the basic properties of an optical fiber, such as its Numerical	PSO 6

	Aperture (NA) and factors affecting light coupling efficiency into the fiber.			
	CO 2. Measure and analyze different types of losses present in an optical fiber.			PSO 6
	CO 3. Characterize the optical sources used in optical communication systems.			PSO 6
	CO 4. Apply the knowledge of optical fiber parameters, sources, and detectors to evaluate the performance of a basic fiber optic link.			PSO 6
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practicals	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Measurement of numerical aperture of optical fiber. 2. Coupling of light into optical fiber and measuring coupling efficiency. 3. Study of losses in optical fiber. 4. Modes of optical fiber. 5. Bending losses in optical fiber. 6. Characteristics of laser diode. 7. Dispersion in optical fiber. 8. Characterization of Photodetector 	30	CO1- CO4	K1-K2- K3-K4- K5-K6
Pedagogy:	Experiential Learning			
Texts:	Gerd Keiser, 'Optical Fiber Communication', MGH, 5 th ED, 2017			
References/ Readings:	<ol style="list-style-type: none"> 1. Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer, "Biomedical instrumentation and Measurements" Prentice Hall India, 2011. 2. Henry W. Ott, "Noise reduction Technique in Electronic systems", Wiley & sons, 1998. 3. Paul Suetens, "Fundamentals of Medical Imaging", 3rd Edition, Cambridge University Press, 2017. 			
Web resource	https://nptel.ac.in/courses/108106167			

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Title of the Course	Digital Image Processing
Course Code	ELE-6203
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Learn and understand the theoretical foundations and mathematical models of digital image representation, processing, and analysis. • Apply pre-processing, image enhancement, filtering, and restoration techniques for improving image quality • Implement image segmentation, morphological operations, feature extraction, and compression techniques for efficient image analysis and representation. 	
Course Outcomes:	The students will:	Mapped to PSO
	CO 1. Explain the fundamental concepts of digital image formation, representation, perception and processing.	PSO 3
	CO 2. Apply image processing techniques such as smoothing, sharpening, and enhancement in	PSO 3, PSO 5

	the spatial and frequency domains to improve image quality.			
	CO 3. Analyse and implement image restoration, segmentation, morphological operations, and feature extraction techniques for various image processing tasks.		PSO 3, PSO5	
	CO 4. Evaluate the performance of object representation and pattern matching techniques.		PSO 3	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction	Digital image fundamentals, Image types and formats, Sampling and quantization, Pixel relationship, Imaging geometry, Image transforms	08	CO1	K1-K3
Module 2: Image Enhancement	Spatial domain- Gray level transformations, Histogram processing, Smoothing and sharpening Spatial filtering. Frequency domain- Fourier Transform, Filtering in frequency domain, Smoothing and sharpening	08	CO2	K1-K3,K5
Module 3: Image Restoration and Segmentation	Image Restoration - Degradation/Restoration model, Noise model, Restoration approach. Segmentation - Detection of discontinuities, Edge linking and boundary detection, Region based segmentation	07	CO3	K1-K3,K5
Module 4: Color Depth and Image Processing Across Spectrum	Color Image Processing - Color models, Color transformations, Smoothing and sharpening, Segmentation. Depth/ RGBD Imaging processing. Image Processing across spectra- Multi-spectral imaging, Hyperspectral Imaging.	08	CO2, CO3	K1-K3,K5
Module 5: Morphological Image Processing and Image Compression	Morphological Image Processing – Dilation and Erosion, Hit or Miss transform. Image Compression – Lossy and Lossless compression, Image compression standards.	07	CO3	K1-K3
Module 6: Feature Extraction, Object	Representation, Boundary descriptors, Regional descriptor, , Image feature extraction Patterns and Pattern classes, Matching and fusion	07	CO3, CO4	K2,K3,K5

Representation, Recognition and Deep Learning	Basics of convolutional neural networks (CNNs)			
Pedagogy:	Lectures/Presentations /Experiential learning			
Texts:	Rafael C Gonzalez and Richard E Woods, 'Digital Image Processing', 4th Edition, Pearson, 2018			
References/ Readings:	<ol style="list-style-type: none"> 1. Anil K Jain, 'Fundamentals of Digital Image Processing', Prentice Hall India Learning Private Limited, 1994 2. William K Pratt, 'Digital Image Processing', 4th Edition, A Wiley-Interscience Publication, 2006 3. Edward R. Dougherty, 'Digital Image Processing Methods', CRC Press, 2020 4. Kumar Navulur, 'Multispectral Image Analysis Using the Object-Oriented Paradigm', CRC Press, 2020 5. Paul L. Rosin, Yu-Kun Lai, Ling Shao, Yonghuai Liu, 'RGB-D Image Analysis and Processing', Springer International Publishing, 2020 6. D. Sundararajan, 'Digital Image Processing - A Signal Processing and Algorithmic Approach', Springer Nature Singapore, 2017 7. Jayaraman S, Veerakumar T, Esakkirajan S, 'Digital Image Processing', McGraw Hill , 2020 			
Web Resources:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/106105032 2. https://onlinecourses.nptel.ac.in/noc25_ee126/preview 			

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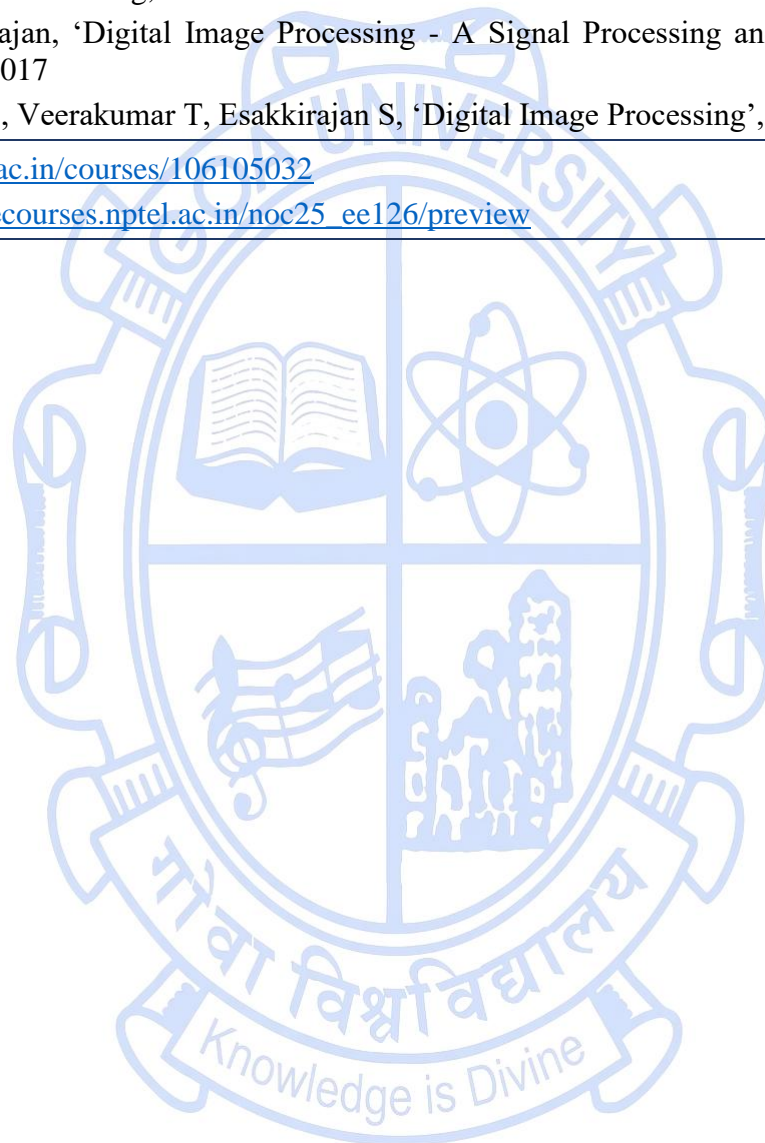
Title of the Course	Digital Image Processing Lab
Course Code	ELE-6204
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Implement the fundamental and mathematical models of digital image representation, processing, and analysis. • Apply pre-processing, image enhancement, filtering, and restoration techniques for improving image quality • Implement image segmentation, morphological operations, feature extraction, and compression techniques for efficient image analysis and representation. • Develop skills in implementing image processing algorithms and apply machine learning or deep learning methods to real-world image analysis tasks. 	
Course Outcomes:	The students will:	Mapped to PSO
	CO 1. Implement image processing techniques and develop applications using image processing tools like Python/MATLAB, including the use of machine learning or deep learning techniques for real-world image analysis.	PSO3, PSO 5

	CO 2. Apply image processing techniques such as smoothing, sharpening, and enhancement in the spatial and frequency domains to improve image quality.		PSO 3, PSO 5
	CO 3. Implement image restoration, segmentation, morphological operations, and feature extraction techniques for various image processing tasks.		PSO 3, PSO5
	CO 4. Evaluate the performance of object representation and pattern matching techniques.		PSO3, PSO 5
Content:		No of hours	Mapped to CO Cognitive Level
Module 1: Practical	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Image enhancement in spatial domain (Smoothing & Sharpening) 2. Image enhancement in frequency domain (Smoothing & Sharpening) 3. Implementing degradation and restoration of image 4. Implement feature extraction algorithms 1 5. Implement feature extraction algorithms 2 6. Implementation of object detection techniques 7. Spatio-spectral image fusion 8. Implementation of histogram equalization 9. Equalization and histogram matching on individual color channels 10. Study of applying erosion, dilation, opening, and closing operations on images 	30	CO1- CO4 K2-K6
Pedagogy:	Presentations /Experiential learning/Lab		
Texts:	Rafael C Gonzalez and Richard E Woods, 'Digital Image Processing', 4th Edition, Pearson, 2018		
References/ Readings:	<ol style="list-style-type: none"> 1. Anil K Jain, 'Fundamentals of Digital Image Processing', Prentice Hall India Learning Private Limited, 1994 2. William K Pratt, 'Digital Image Processing', 4th Edition, A Wiley-Interscience Publication, 2006 3. Edward R. Dougherty, 'Digital Image Processing Methods', CRC Press, 2020 4. Kumar Navulur, 'Multispectral Image Analysis Using the Object-Oriented Paradigm', CRC Press, 2020 5. Paul L. Rosin, Yu-Kun Lai, Ling Shao, Yonghuai Liu, 'RGB-D Image Analysis and Processing', Springer 		

	International Publishing, 2020 6. D. Sundararajan, 'Digital Image Processing - A Signal Processing and Algorithmic Approach', Springer Nature Singapore, 2017 7. Jayaraman S, Veerakumar T, Esakkirajan S, 'Digital Image Processing', McGraw Hill , 2020
Web Resources:	1. https://nptel.ac.in/courses/106105032 2. https://onlinecourses.nptel.ac.in/noc25_ee126/preview

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Title of the Course	Neuromorphic Computing
Course Code	ELE-6205
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

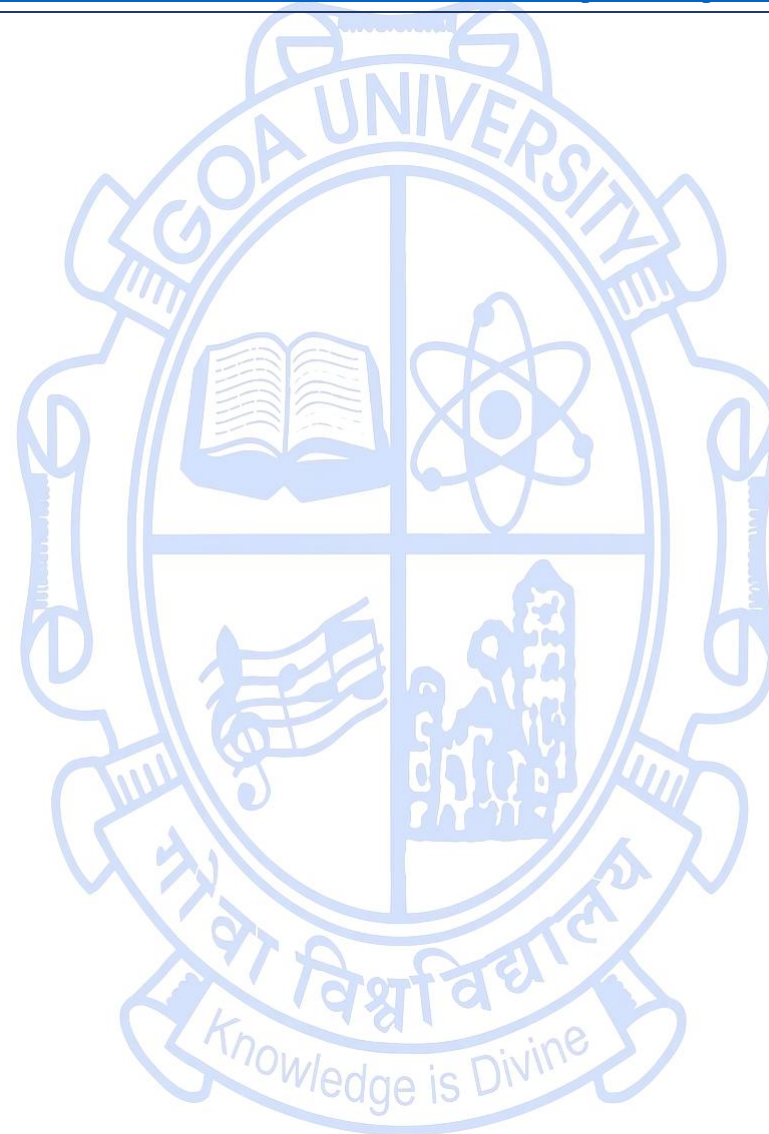
Pre-requisites for the Course:	Nil	
Course Objectives:	This course is intended to: <ul style="list-style-type: none"> • Introduce Neuromorphic computing and spiking neural networks (SNN). • Introduce operational principles and learning models for Artificial Neural Networks and Spiking Neural Networks • Cover various Neuromorphic computing architectures 	
Course Outcomes:		Mapped to PSO
	CO1. Understand and apply the concepts of brain-inspired computing	PSO 1
	CO2. To Understand and apply the concepts of neural networks	PSO 1
	CO3. Apply, analyse and implement the concepts of SNN	PSO 3
	CO4. Understanding the advances in neuromorphic architectures and emerging technologies	PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction	Introduction: Basics of brain-inspired computing and history of neural computing, Comparison of neuromorphic and conventional computing, Spiking Neural Network(SNN) overview	5	CO1,	K1,K2, K3
Module 2: Shallow Neural Networks	Deep learning techniques using convolutional neural networks(VGG, Inception Net, MobileNet), Python programming preliminaries for Neural Net, Shallow neural networks – Perceptron, Hopfield network, Boltzmann machine, Recurrent neural network, and Kohonen’s self-organizing map	10	CO2	K2, K3, K5,
Module 3: Fundamentals of SNN	Difference between Spiking Neural Networks (SNNs) and Traditional ANN, SNN Fundamentals, spikes, sparsity, Neuron Models: Leaky-Integrate-and-Fire (LIF) model, Izhikevich model, Hodgkin-Huxley model, Spike Encoding: temporal encoding, rate-based encoding, SNN Training algorithms: Loss calculations, Surrogate Gradients, Spike-Timing-Dependent Plasticity (STDP).	17	CO3	K4, K5, K6
Module 4: Neuromorphic architectures	Neuromorphic computing architectures- Loihi, Brainchip and SpiNNaker, Commercial hardware acceleration platforms such as Graphics processing unit (GPU), FPGA accelerators.	8	CO4	K1,K2, K3
Module 5: Emerging technologies	Applications and Emerging technologies in neuromorphic circuits such as memristors, spin transfer torque devices, and photonic devices.	5	CO4	K1,K2, K3
Pedagogy:	Lectures/Experiential Learning			
Texts:	Nan Zheng and Pinaki Mazumder, “Learning in Energy-Efficient Neuromorphic Computing: Algorithm and Architecture Co-Design”, John Wiley & Sons, USA, 2019.			
References/ Readings:	<ol style="list-style-type: none"> 1. Abderazek Ben Abdallah, Khanh N. Dang, “ Neuromorphic Computing Principles and Organization” Springer (31 May 2022). 2. Aaron C. Courville, Ian Goodfellow, and Yoshua Bengio, “Deep Learning”, MIT Press, 2015. 3. Pinaki Mazumder, Yalcin Yilmaz, Idongesit Ebong, “Neuromorphic Circuits for Nanoscale Devices”, River Publishing, 2019. 			

Web Resources:

<https://www.intel.com/content/www/us/en/research/neuromorphic-computing.html>

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Title of the Course	Neuromorphic Computing Lab
Course Code	ELE-6206
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course aims to:</p> <ul style="list-style-type: none"> • Provide hands on approach to foundational concepts of neuromorphic computing and spiking neural networks (SNNs). • Practical approach to the operating and learning mechanisms behind both artificial neural networks and spiking neural networks. • Explore application of SNN for classification and regression. 	
Course Outcomes:		Mapped to PSO
	CO1. Understand and apply the concepts of Shallow neural networks	PSO 1
	CO2. To Understand and apply the concepts of encoding for SNN	PSO 1
	CO3. To implement the concepts of Leaky-Integrate-and-Fire neuron	PSO 3

	CO4. Develop competency in utilizing SNN based classification and regression		PSO 3	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1 :Practical	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Study of Shallow neural networks -SOMs 2. Study of perception neural network 3. Implementation of Deep Neural Network 4. Implementation of Rate Encoding for SNN 5. Implementation of temporal Encoding for SNN 6. Implementation of Delta Modulation for SNN 7. Implementation of Leaky-Integrate-and-Fire neuron 8. Implementation of SNN for classification -I 9. Implementation of SNN for classification -II 10. Implementation of SNN for regression 	30	CO1, CO2, CO3, CO4	K3, K4, K5, K6
Pedagogy:	Experiential Learning/Practicals			
Texts:	Nan Zheng and Pinaki Mazumder, “Learning in Energy-Efficient Neuromorphic Computing: Algorithm and Architecture Co-Design”, John Wiley & Sons, USA, 2019.			
References/ Readings:	<ol style="list-style-type: none"> 1. Abderazek Ben Abdallah, Khanh N. Dang, “ Neuromorphic Computing Principles and Organization” Springer (31 May 2022). 2. Aaron C. Courville, Ian Goodfellow, and Yoshua Bengio, “ Deep Learning”, MIT Press, 2015. 3. Pinaki Mazumder, Yalcin Yilmaz, Idongesit Ebong, “Neuromorphic Circuits for Nanoscale Devices”, River Publishing, 2019. 			
Web Resources:	https://www.intel.com/content/www/us/en/research/neuromorphic-computing.html			

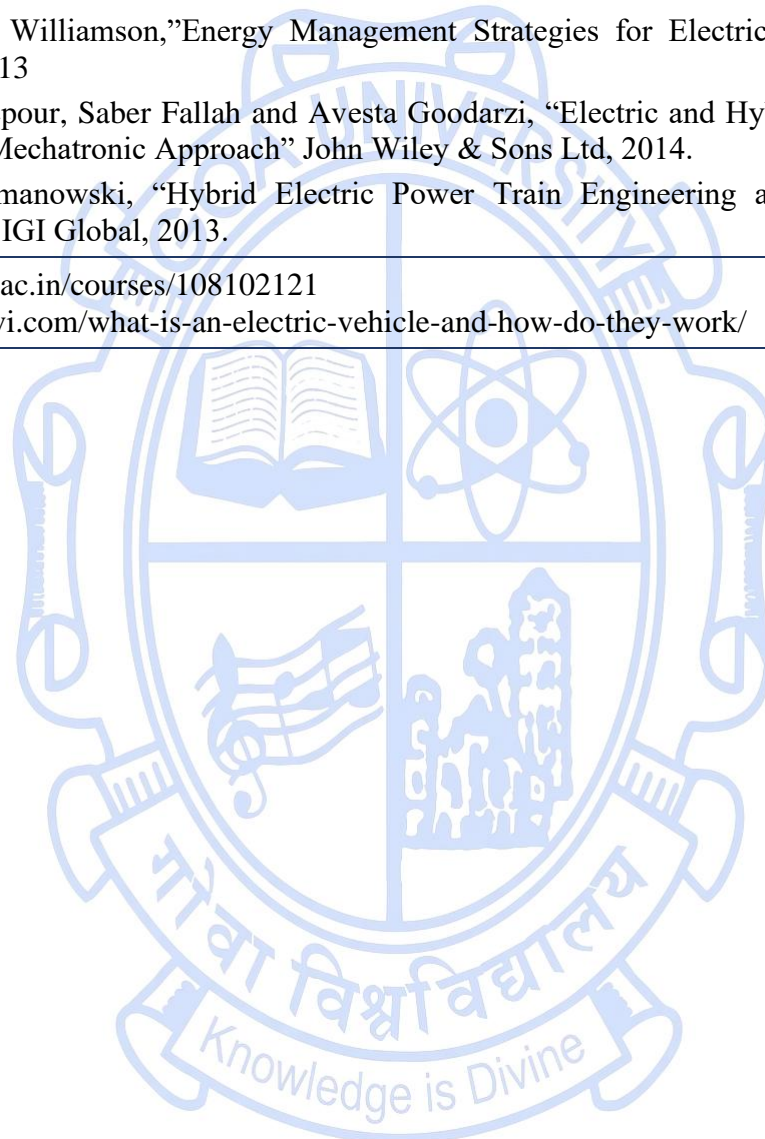
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Title of the Course	Electric Vehicle Technology	
Course Code	ELE-6207	
Number of Credits	03	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-2027	
New Course	Yes	
Bridge Course/ Value added Course	No	
Course for advanced learners	Yes	
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Introduce Hybrid & Electric Vehicle • Cover various types of Electric Drives and energy • Energy storage and management • Understanding EV policy and roadmaps 	
Course Outcomes:		Mapped to PSO
	CO1. To understand about basics of hybrid electric vehicle	PSO 1
	CO2. To understand about drives and control.	PSO 1
	CO3. Select battery, battery indication system for EV applications	PSO 2

	CO4. understand Vehicle performance parameter EV policy and roadmap	PSO 3, PSO4		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction to Hybrid Electric Vehicle and Electric Drives	1.1 Review of Conventional Vehicle, Introduction to Hybrid Electric Vehicles, Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving 1.2 Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, BLDC, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor	15	CO1, CO2	K1,K2
Module 2: Energy Storage and Management System	2.1 Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle 2.2 Energy Management Strategies, Automotive networking and communication, EV charging standards, V2G, G2V, V2B, V2H	15	CO3	K2
Module 3: Mobility - Connectors and Modelling of Vehicle Performance Parameter	3.1 Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Connectors- Types of EV charging connector, North American EV Plug Standards, DC Fast Charge EV Plug Standards in North America, CCS (Combined Charging System), CHAdEMO, Tesla, European EV Plug Standards	15	CO4	K3
Pedagogy:	Lectures			
Texts:	<ol style="list-style-type: none"> Suresh Nagappan Sundaram Etal., ‘Electric Vehicle Technology Structure, Instrumentation and Challenges’, Nova Science,2024 Emadi, A. (Ed.), Miller, J., Ehsani, M., Boca Raton, “Vehicular Electric Power Systems” CRC Press, 2003 Husain, I. Boca Raton,“Electric and Hybrid Vehicles” , CRC Press, 2010. 			
References/	<ol style="list-style-type: none"> Tariq Muneer and Irene IllescasGarcía, ,“The automobile, In Electric Vehicles: Prospects and Challenges” , 			

Readings:	<p>Elsevier, 2017</p> <ol style="list-style-type: none"> 2. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles" , Springer, 2013 3. Amir Khajepour, Saber Fallah and Avesta Goodarzi, "Electric and Hybrid Vehicles Technologies, Modelling and Control: A Mechatronic Approach" John Wiley & Sons Ltd, 2014. 4. Antoni Szumanowski, "Hybrid Electric Power Train Engineering and Technology: Modelling, Control, and Simulation" IGI Global, 2013.
Web Resources:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/108102121 2. https://ennovi.com/what-is-an-electric-vehicle-and-how-do-they-work/

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Title of the Course	Electric Vehicle Technology Lab
Course Code	ELE-6208
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	YES
Bridge Course/ Value added Course	No
Course for advanced learners	No

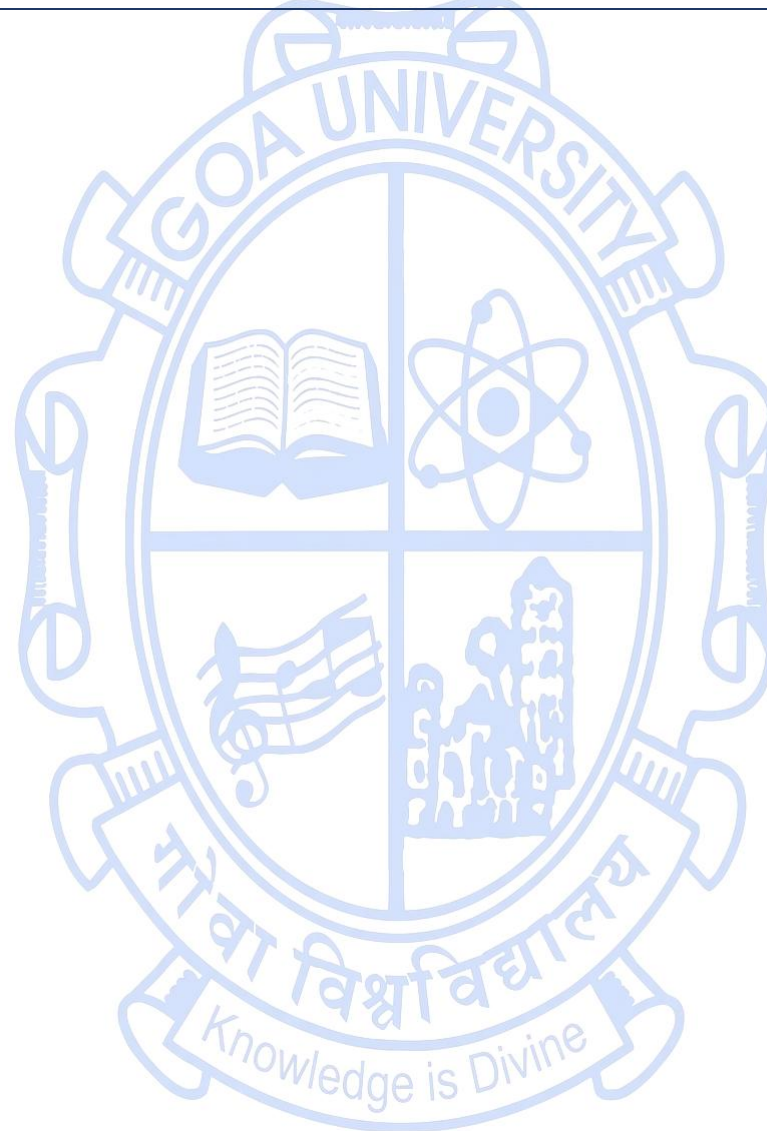
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Acquire expertise in power electronics • Modelling and Characteristics of EV/HEV Powertrains Components • Modelling Electric Vehicle Range • MATLAB Simulink modelling of Electric Vehicle 	
Course Outcomes:		Mapped to PSO
	CO 1. Acquire expertise in power electronics: electric drivetrain and charging infrastructure design.	PSO 1
	CO 2. Modelling and Characteristics of EV/HEV Powertrains Components	PSO 1
	CO 3. Gain hands-on experience in Modelling Electric Vehicle Range	PSO 3

	CO 4. Design battery charger for an EV & Modelling of Electric Vehicle in MATLAB		PSO 3	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practical	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Electric Vehicle Modelling - Tractive Effort, Rolling resistance force, Aerodynamic drag, 2. Electric Vehicle Modelling :Hill climbing force, Acceleration force, Total tractive effort 3. Modelling Electric Vehicle Range - Range modelling of battery electric vehicles, Constant velocity range modelling, 4. Range modelling of fuel cell vehicles, 5. Range modelling of hybrid electric vehicles 6. Modelling and Characteristics of EV/HEV Powertrains Components- ICE Performance Characteristics, 7. Electric Motor Performance Characteristics - Battery Performance 8. Propulsion Modelling and Analysis - Vehicle Braking Modelling and Analysis 9. Modelling Vehicle Acceleration - Acceleration performance parameters, modelling the acceleration of an electric scooter, 10. Modelling the acceleration of a small car. 	30	CO1, CO2, CO3, CO4	K3, K4,
Pedagogy:	Experiential Learning/Practicals			
Texts:	Larminie, James, and John Lowry, “Electric Vehicle Technology Explained” John Wiley and Sons, 2012			
References/ Readings:	<ol style="list-style-type: none"> 1. Tariq Muneer and Irene IllescasGarcía, ,“The automobile, In Electric Vehicles: Prospects and Challenges” , Elsevier, 2017 2. Sheldon S. Williamson ,”Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles” , Springer, 2013 3. Amir Khajepour, Saber Fallah and Avesta Goodarzi, “Electric and Hybrid Vehicles Technologies, Modelling and Control: A Mechatronic Approach” John Wiley & Sons Ltd, 2014. 4. Antoni Szumanowski, “Hybrid Electric Power Train Engineering and Technology: Modelling, Control, and Simulation” IGI Global, 2013. 			

Web Resources:

<https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work>

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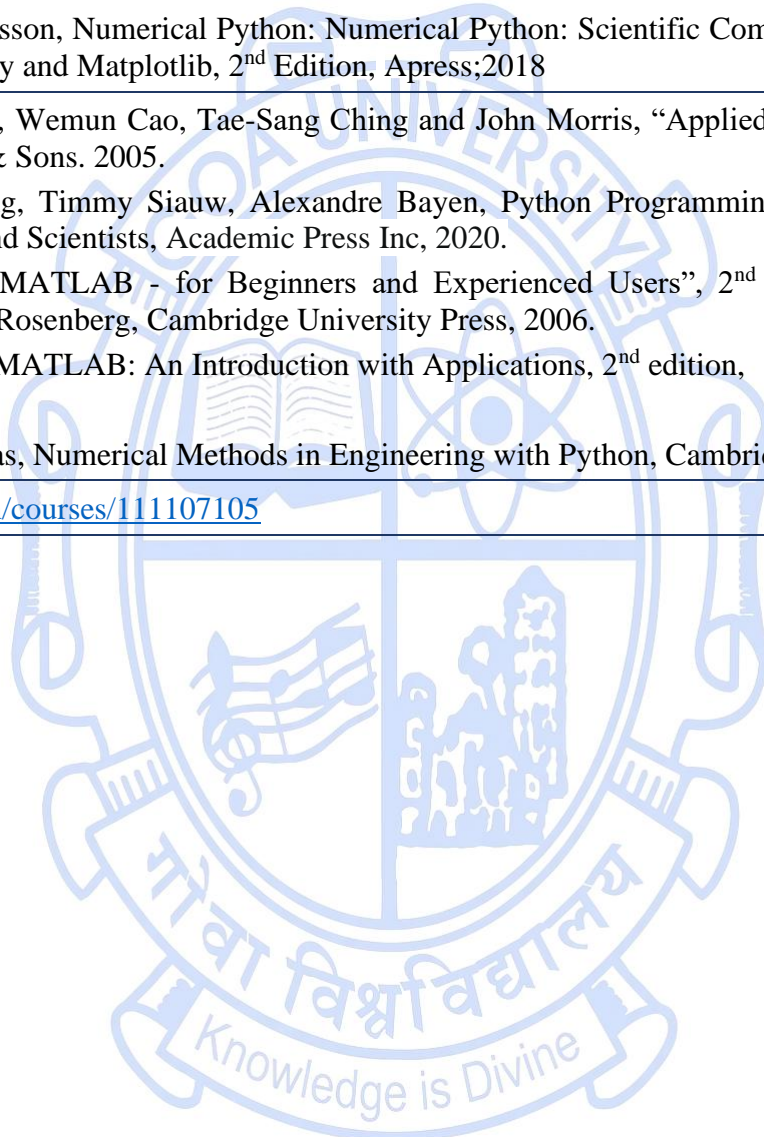
Title of the Course	Data Analysis and Visualization
Course Code	ELE-6209
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Should have basic understanding of programming language at graduate level.	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • To familiarize students with the programming fundamentals. • To enable the students to solve basic problems and matrix operations. • To enable students to solve scientific problems using programming language. • To provide overview of numerical techniques to solve differential equations, non-linear equations and numerical integration using programming language. 	
Course Outcomes:	CO 1. Basic understanding of programming.	Mapped to PSO PSO 5
	CO 2. Create and control simple plots and user interface graphics, and objects.	PSO 5

	CO 3. Execute loops, conditional statements, control instructions, and functions within the programming environment.		PSO 5	
	CO 4. Apply curve fitting and interpolation technique on data.		PSO 5	
	CO 5. Able to solve ODE using ode solver and execute solutions of nonlinear equations and DFT.		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Basic mathematical operations with arrays	1-D and 2-D array, Creating a two dimensional array (matrix): The zeros, ones and eye Commands, Notes about variables, The transpose operator, 1-D and 2-D arrays, addition and subtraction, array multiplication and division, element-by-element operations, generation of random numbers, analysing arrays using built-in math functions.	7	CO1	K2-K3-K4
Module 2: Plotting	Basic plot commands: plot, formatting a plot, subplots, basic 2D and 3D plots: Line plots, mesh and surface plots, contour, View command, formatting a Plot Using Commands & Plot Editor, Histograms.	6	CO2	K2-K3-K4
Module 3: Functions and programming construct	Script files, Functions files, Language specific features, Advanced Data objects, Conditional statements, loops, nested loops, application of break, and continue commands, Relational and Logical operators, conditional statements.	12	CO3	K2-K3
Module 4: Polynomial, Curve-fitting, Interpolation	Polynomials, curve fitting, Interpolation, Spline interpolation. The Basic fitting interface, Examples, solving equation of one variable, Finding minimum or maximum of a function.	8	CO4	K3, K5
Module 5: Mathematical computing	Algebraic equations: Eigen values, Eigen vectors, solution of a system of linear equations and non-linear equation, numerical integration, Introduction to ordinary differential equations (ODE), solution of first order ODE, ODE solvers, Transforms: Discrete Fourier Transform.	12	CO5	K5
Pedagogy:	Lectures/Experiential Learning			
Texts:	1. Rudra Pratap, Getting Started with MATLAB-A Quick Introduction for Scientists and Engineers, Oxford University			

	<p>Press. 2003.</p> <p>2. Robert Johansson, Numerical Python: Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, 2nd Edition, Apress;2018</p>
References/ Readings:	<ol style="list-style-type: none"> 1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, “Applied Numerical Methods Using MATLAB”, A John Wiley & Sons. 2005. 2. Qingkai Kong, Timmy Siau, Alexandre Bayen, Python Programming And Numerical Methods: A Guide For Engineers And Scientists, Academic Press Inc, 2020. 3. A Guide to MATLAB - for Beginners and Experienced Users”, 2nd Ed., Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Cambridge University Press, 2006. 4. Amos Gilat, MATLAB: An Introduction with Applications, 2nd edition, Wiley, 2004. 5. Jaan Kiusalaas, Numerical Methods in Engineering with Python, Cambridge University Press, 2005.
Web resource	https://nptel.ac.in/courses/111107105

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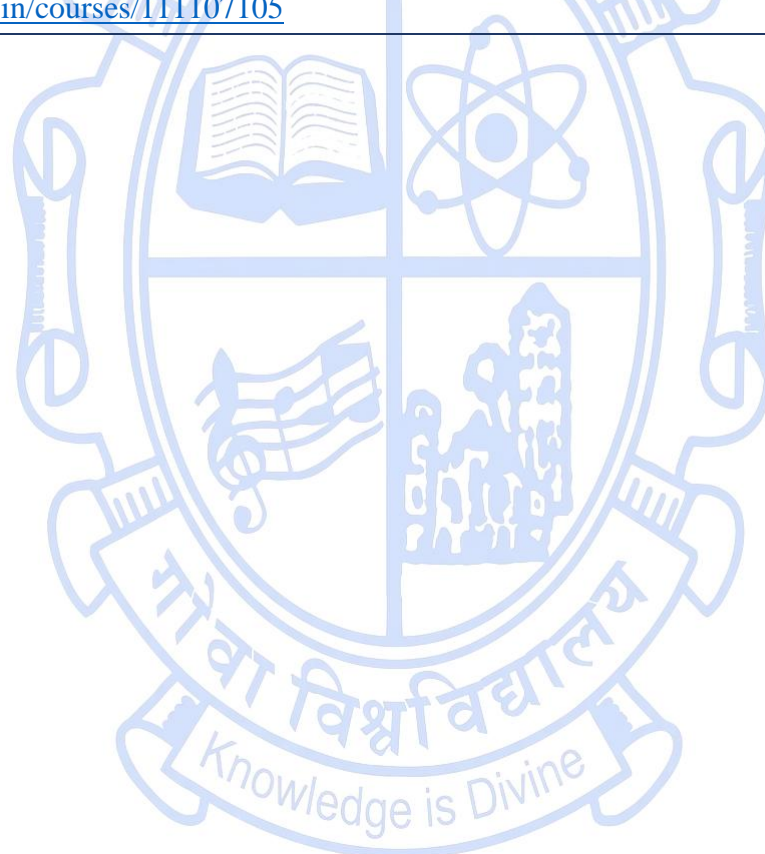
Title of the Course	Data Analysis and Visualization Lab
Course Code	ELE-6210
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Introduce the concepts of matrix and vector operations and their implementation using computational tools for tasks like evaluating Eigen values/vectors and solving linear equations. • Develop proficiency in using programming environment to handle data (1D and 2D arrays) and perform necessary arithmetic operations on them. • Familiarize with data visualization and data analysis for interpreting experimental or calculated results. • Provide hands-on experience in applying various standard numerical methods to solve complex mathematical problems. 	
Course Outcomes:	CO 1. Implement and manipulate arrays and matrices within a programming environment, using them to computationally solve systems of linear equations and find Eigen	Mapped to PSO PSO 5

	values/vectors.			
	CO 2. Generate and customize various forms of data visualization to represent data and perform curve fitting for modeling experimental trends.		PSO 5	
	CO 3. Evaluate and implement definite integrals using the principles of numerical integration methods.		PSO 5	
	CO 4. Apply appropriate numerical methods to solve single-variable non-linear equations and first-order Ordinary Differential Equations.		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Practicals	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1) Create 1 and 2-D arrays and access specific numbers in arrays using their position and perform different arithmetic operations on arrays. 2) Create 2D and 3D plots formatting the plots using basic commands and create subplots. 3) Study of curve fitting tool box 4) Evaluate Eigen values and Eigen vectors of a given matrix. 5) Solve linear equation using Gauss-Jordon method 6) Solve non-linear equation using Newton-Raphson method 7) Solve a first order ODE by Runge Kutta method 8) To evaluate numerical integration by using Trapezoidal and Simpson's rule. 	30	CO1- CO4	K2-K3- K4-K5- K6
Pedagogy:	Lectures/Experiential Learning			
Texts:	<ol style="list-style-type: none"> 1. Rudra Pratap, Getting Started with MATLAB-A Quick Introduction for Scientists and Engineers, Oxford University Press. 2003. 2. Robert Johansson, Numerical Python: Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, 2nd Edition, Apress;2018 			
References/ Readings:	1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, "Applied Numerical Methods Using MATLAB", A			

	<p>John Wiley & Sons. 2005.</p> <ol style="list-style-type: none">2. Qingkai Kong, Timmy Siau, Alexandre Bayen, Python Programming And Numerical Methods: A Guide For Engineers And Scientists, Academic Press Inc, 2020.3. A Guide to MATLAB - for Beginners and Experienced Users”, 2nd Ed., Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Cambridge University Press, 2006.4. Amos Gilat, MATLAB: An Introduction with Applications, 2nd edition, Wiley, 2004.5. Jaan Kiusalaas, Numerical Methods in Engineering with Python, Cambridge University Press, 2005.
Web resource	https://nptel.ac.in/courses/111107105

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Title of the Course	Edge Computing	
Course Code	ELE-6211	
Number of Credits	03	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-2027	
New Course	YES	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Introduce the foundation concepts in the Edge Computing related to IoT. • Become familiar with basic Knowledge to implement Edge on Raspberry pi systems. • Familiarize with the jetson computing platform for Edge computing • Give hands on training to leverage Edge computing for real world applications 	
Course Outcomes:		Mapped to PSO
	CO1. Understand the fundamental and architectures of Edge computing in relation to IoT	PSO 1
	CO2. Apply Edge computing concepts on Raspberry Pi platform.	PSO 1
	CO3. Gain skills to deploy Edge IoT on Jetson computing.	PSO 5

	CO4. Design real world applications using the concepts of Edge IoT.	PSO 5		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction	Overview of IoT and Edge Computing, Architecture of IoT, Architecture of Edge Computing, Relationship with other FoG and Cloud Computing. Role of Edge in IoT, Edge computing hardware architectures, Edge platforms, Application of Edge computing.	12	CO1	K1,K2
Module 2: Raspberry Pi for Edge computing	Introduction, RaspberryPi architecture and Hardware Layout, Configuring RaspberryPi, Review of Python programming, Programming RaspberryPi, Connecting Raspberry Pi via SSH, Remote access tools, interfacing sensors to Raspberry Pi, Edge to Cloud Protocols, MQTT protocol for communications, working example, Edge computing with RaspberryPi. Application in Home Surveillance and Patient monitoring systems	17	CO2, CO4	K3-K5
Module 3: Jetson for Edge computing	Introduction, Jetson architecture and Hardware Layout, Jetson Board Features and Configuration, Programming Jetson, Connecting Jetson, Interfacing sensors to Jetson, Concepts of Machine Learning (ML) on edge devices, Machine Learning (ML) in IoT with Jetson Nano, Pattern Recognition Using edge computing, Object Classification Using ML, Regression on Edge device,	16	CO3, CO4	K3-K5
Pedagogy:	Lectures/Experiential Learning			
Texts:	Edge Computing: Fundamentals, Advances and Applications by D. Dharani, G. Sudha Sadasiva, K. Anitha Kumari, M. Niranjanamurthy, Taylor & Francis Ltd; 1st edition (23 December 2021)			
References/ Readings:	<ol style="list-style-type: none"> 1. “Fog and Edge Computing: Principles and Paradigms”, Rajkumar Buyya (Editor), Satish Narayana Srirama (Editor), Wiley, 2019. 2. Python Programming Recipes for Iot Applications, Jivan S. Parab Madhusudan Lanjewar, Springer Nature; 2023rd edition (8 June 2023) 3. Cloud Computing: Principles and Paradigms”, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley, 2011 4. “Cloud and Distributed Computing: Algorithms and Systems”, Rajiv Misra, Yashwant Patel, Wiley 2020. 			
Web Resources:	https://nptel.ac.in/courses/106104449			

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Title of the Course	Edge Computing Lab
Course Code	ELE-6212
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	YES
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Present the fundamental concepts of configuring edge computing on various platforms. • Build basic knowledge needed to deploy edge solutions on Raspberry Pi systems. • Introduce the Jetson platform as a tool for edge computing. • Develop expertise in the area of deploying classification and regression applications. 	
Course Outcomes:		Mapped to PSO
	CO1. Understand the Configuration of various platforms for Edge Computing.	PSO 1
	CO2. Hand on approach for interfacing sensors on edge computing.	PSO 1
	CO3. Implement Machine learning on various platforms	PSO 5

	CO4. Develop competency in utilizing edge for classification and regression		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 4: Practical	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Configuring of Raspberry for computing. 2. Configuring of Jetson for computing. 3. Sensor interfacing using Raspberry Pi . 4. Implementation of Home Surveillance system on Raspberry Pi 5. Sensor interfacing using Jetson board . 6 Implementation of Patient monitoring system 7. Implementation of Machine Learning on Jetson 8. Implementation of Pattern Recognition Using edge computing 9. Implementation of Object Classification Using ML. 10. Implementation of Regression on Edge device. 	30	CO1, CO2, CO3, CO4	K2-K6
Pedagogy:	Practicals/Experiential Learning			
Texts:	Edge Computing: Fundamentals, Advances and Applications by D. Dharani, G. Sudha Sadasiva, K. Anitha Kumari, M. Nirananamurthy, Taylor & Francis Ltd; 1st edition (23 December 2021)			
References/ Readings:	<ol style="list-style-type: none"> 1. “Fog and Edge Computing: Principles and Paradigms”, Rajkumar Buyya (Editor), Satish Narayana Srirama (Editor), Wiley, 2019. 2. Python Programming Recipes for Iot Applications, Jivan S. Parab Madhusudan Lanjewar, Springer Nature; 2023rd edition (8 June 2023) 3. Cloud Computing: Principles and Paradigms”, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley, 2011 4. “Cloud and Distributed Computing: Algorithms and Systems”, Rajiv Misra, Yashwant Patel, Wiley 2020. 			
Web Resources:	https://nptel.ac.in/courses/106104449			

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Title of the Course	Robotics
Course Code	ELE-6213
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Understand the fundamental concepts of robotics, including types, classifications, laws, and various industrial and societal applications and ROS. • Learn the core components and mathematical representations of robots, such as links, joints, actuators, sensors, and Denavit-Hartenberg (D-H) parameters. • Analyze and solve kinematics and dynamics problems for both serial and parallel robot manipulators, incorporating velocity, statics, and control principles. • Explore current and futuristic robotics technologies and applications, including UAVs, humanoid robots, cognitive robotics, and defence-related systems. 	
Course Outcomes:	The Students will:	Mapped to PSO
	CO 1. Gain knowledge of the basic concepts in robotics, ROS, classification, and applications of	PSO 2

	robots across different industries and domains			
	CO 2. Analyze robotic systems using key parameters such as D-H notation, joint representations, and sensor/actuator integration.			PSO 2, PSO 5
	CO 3. Analyze and solve problems related to direct and inverse kinematics, velocity, and statics of serial and parallel manipulators, and apply robot dynamics and control techniques to design effective trajectory tracking.			PSO 2
	CO 4. Demonstrate proficiency in programming and real-time interfacing of microcontrollers			PSO 2
	CO 5. Describe and evaluate advanced and emerging robotics technologies			PSO2, PSO 5
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1: Introduction	Brief history, types, classification and usage; Laws of Robotics; Robot applications- Manufacturing industry, defence, rehabilitation, medical, etc.; Introduction to ROS	08	CO1, CO2	K1,K2
Module 2: Elements of robots	Links, joints, actuators, and sensors (like proximity, and distance measuring sensors, and vision sensors) Position and orientation of a rigid body, Homogeneous transformations; Representation of joints, link representation using D-H parameters, Examples of D-H parameters, and link transforms;	08	CO2	K1-K3
Module 3: Kinematics	Direct and Inverse Kinematics; Kinematics of serial robots: Direct and inverse kinematics problems, Inverse kinematics of constrained and redundant robots Kinematics of parallel robots: direct and inverse kinematics problems, Mobility, Stewart Gough platform, Degrees-of- freedom of parallel mechanisms and manipulators	07	CO3	K2-K4
Module 4: Velocity, Static analysis, Robot Dynamics & Controls	Linear and angular velocities; Jacobians: Serial and parallel manipulators; Static analysis: Force and torque calculations; Dynamic modelling of manipulators (overview), Trajectory generation and tracking , PD/PID controllers	08	CO3	K2-K3

Module 5: Embedded Systems and Real-Time Control	Review of Microcontrollers and SoC (Arduino/STM32/Raspberry Pi), Real-time interfacing, programming and communication	07	CO4	K1-K3
Module 6: Robotics Applications and Emerging Technologies	Design and operation of UAVs, drones, humanoid robots, and underwater robots (overview); Introduction to MEMS in robotics; Cognitive robotics and Wearable and medical robotics; Space and defence robotics	07	CO5	K1-K2
Pedagogy:	Presentations /assignments/Experiential learning/Lab			
Texts:	<ol style="list-style-type: none"> 1. S K. Saha, 'Introduction to Robotics', McGraw Hill 3rd Edition, 2025 2. John J Craig, 'Introduction to Robotics', Prentice Hall International, 3rd ED, 2005 			
References/ Readings:	<ol style="list-style-type: none"> 1. Robert J Schilling, 'Fundamentals of Robotics', Prentice Hall India, 1st ED, 2003 2. Ghosal, A., 'Robotics: Fundamental Concepts and Analysis', Oxford University Press, 9th reprint, 2013 3. Jitendra R. Raol, Ramakalyan Ayyagari, 'Control Systems: Classical, Modern, and AIBased Approaches', CRC Press, 1st ED, 2019 4. Gao, Yang, 'Space Robotics and Autonomous Systems', Institution of Engineering & Technology, 2021 5. Lentin Joseph, Aleena Johny, 'Robot Operating System (ROS) for Absolute Beginners', 2nd ED, 2022 			
Web Resources:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc25_me161/preview 2. https://nptel.ac.in/courses/107106090 			

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Title of the Course	Robotics Lab
Course Code	ELE-6214
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	<p>This course is intended to:</p> <ul style="list-style-type: none"> • Gain hands-on experience in robotics implementation using simulation tools, Embedded platforms and robotic systems. • Understand and Simulate the transformations and Denavit-Hartenberg (D-H) parameters. • Implement and solve kinematics problems. 	
Course Outcomes:	The Students will:	Mapped to PSO
	CO 1. Demonstrate practical skills in robot programming and simulation	PSO2, PSO 5
	CO 2. Simulate the transformations and Denavit-Hartenberg (D-H) parameters.	PSO 2, PSO 5
	CO 3. Solve kinematics and trajectory tracking problems.	PSO2, PSO 5

	CO 4. Demonstrate proficiency in developing microcontrollers based robotic application		PSO2, PSO 5
Content:		No of hours	Mapped to CO Cognitive Level
Module 1: Practical	<p>(Note: Minimum 6 experiments are to be performed)</p> <ol style="list-style-type: none"> 1. Setup and program a basic mobile robot using Arduino/ESP32/ Raspberry Pi 2. Designing an obstacle avoidance robot 3. Designing a line follower robot. 4. Implement forward kinematics for n-DOF arm (simulation or hardware) 5. Simulation of Homogeneous transformations 6. Simulation of D-H parameters 7. Wireless Robot Control via Bluetooth/Wi-Fi 8. Simulation of Trajectory Planning 9. Vision-Based Robot Control Simulation 10. Implementation of Pick-and-place task using robotic arm 	30	CO1- CO4 K3-K6
Pedagogy:	Presentations /assignments/Experiential learning/Lab		
Texts:	<ol style="list-style-type: none"> 1. S K. Saha, 'Introduction to Robotics', McGraw Hill 3rd Edition © 2025 2. John J Craig, 'Introduction to Robotics', Prentice Hall International, 3rd ED, 2005 		
References/ Readings:	<ol style="list-style-type: none"> 1. Robert J Schilling, 'Fundamentals of Robotics', Prentice Hall India, 1st ED, 2003 2. Ghosal, A., 'Robotics: Fundamental Concepts and Analysis', Oxford University Press, 9th reprint, 2013 3. Jitendra R. Raol, Ramakalyan Ayyagari, 'Control Systems: Classical, Modern, and AIBased Approaches', CRC Press, 1st ED, 2019 4. Gao, Yang, 'Space Robotics and Autonomous Systems', Institution of Engineering & Technology, 2021 5. Lentin Joseph, Aleena Johny, 'Robot Operating System (ROS) for Absolute Beginners', 2nd ED, 2022 		
Web Resources:	<ol style="list-style-type: none"> 1. https://onlinecourses.nptel.ac.in/noc25_me161/preview 2. https://nptel.ac.in/courses/107106090 		

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