ANNEXTURE-I

SYLLABUS OF M.SC. (ELECTRONICS) (Effective from AY: 2018-19)

The Couse requirement is completion of 64 credits(ie 16 credits/semester,

SR. NO	COURSE CODE	TITLE	CREDITS	TYPE
SEMESTER-I				
1	ELC 101	MICROELECTRONICS AND VLSI DESIGN	4	L
2	ELO 101	ADVANCED DIGITAL COMMUNICATION SYSTEMS	4	L
3	ELO 102	NUMERICAL COMPUTATION AND ALGORITHMS**(FLIPPED CLASSROOM)**	4	L
4	ELC 102	ELECTRONICS PRACTICALS – I	4	P
5	ELO 181	**SWAYAM-I**	4	L
		TOTAL	16	
SEMESTER II				
1	ELC 201	EMBEDDED SYSTEMS DESIGNS and IoT**(FLIPPED CLASSROOM)**	4	L
2	ELO 201	OPTICAL COMMUNICATION SYSTEMS	4	L
3	ELO 202	OPERATING SYSTEM AND RTOS	4	L
4	ELC 202	ELECTRONICS PRACTICALS- II	4	P
5	ELO 281	**SWAYAM-II**	4	L
6	ELO 203	BASICS OF MEDICAL IMAGING	1	L
7	ELO 204	DATA SCIENCE AND MACHINE LEARNING	4	L
		TOTAL	16	
SEMESTER III				
1	ELC 301	SIGNALS AND SYSTEMS	4	L
2	ELO 301	DIGITAL SIGNAL PROCESSING	4	L
3	ELO 302	INSTRUMENTATION & CONTROL THEORY	4	L
4	ELC 302	ELECTRONICS PRACTICALS - III	4	P
5	ELO 381	**SWAYAM-III**	4	L
6	ELO 303	DIGITAL SYSTEM DESIGN USING HDL	4	L
7	ELO 304	EDA TOOLS **(FLIPPED CLASSROOM)**	4	L
8	ELO 305	INDUSTRIAL INTERNSHIP	1	L+P

		TOTAL	16	
SEMESTER IV				
1	ELO 401	PROJECT	8	P
2	ELC 401	LASER SYSTEM ENGINEERING	4	L
3	ELC 402	ELECTRONICS PRACTICALS - IV	4	P
4	ELO 481	**SWAYAM-IV**	4	L
5	ELO 402	NANOELECTRONICS & NANOSYSTEMS	4	L
6	ELO 403	PHARMACEUTICAL INSTRUMENTATION	4	L
7	ELO 404	COMMUNICATION AND TECHNICAL SKILLS **(FLIPPED CLASSROOM)**	4	T+P
		TOTAL	16	

Programe: M. Sc. (Electronics)

SEMESTER I

Course Code: ELC101 Title **of the Course:** MICROELECTRONICS AND VLSI DESIGN
Number of Credits: 4

Prerequisites for the course:	Should have graduate level knowledge in analog and digital electronics	
Objective:	This subject will introduce to the VLSI Technology , various fabrications processes involved in IC design , Electrical and Electronics analysis of few circuits, Some Design examples of VLSI circuits, Circuit Optimization techniques, Advance circuits designs examples of Memory, Registers, Synchronous circuits etc.	
Content:	An overview of VLSI, Modern CMOS Technology Silicon Logic, Logic design with MOSFET. Physical structure of CMOS Integrated circuits Fabrication Technologies of CMOS Integrated Circuits Elements of Physical Design Electrical characteristics of MOSFETS Electronic analysis of CMOS Logic gates	4 5 4 7 3 6 5

	Advanced Techniques in CMOS Logic Circuits System specifications using HDL, General VLSI components Memories and Programmable Logic Tutorials: 1.2nd order Butterworth filter using P-Spice student version. 2 Current Mirrors using P-Spice student version. 3.CMOS based Op-Amp using P-Spice student version. 4.Study of Lithography. 5.Compares various Static memories.	6 4 4
	Total	48
Pedagogy:	Lectures/ tutorials/assignments/self-study	
References/Readings	1. Introduction to VLSI Circuits and Systems, John P. Uyemura, WILLEY. 2. Principles of CMOS VLSI Design, N.H.E. W. & Eshahiraghian, Addison Wesley 3. Modern VLSI Design System on Silicon, Pearson Education Asia. By W. Wolf. 4. VLSI Technology, S.M. Sze, McGraw -Hill (1995). 5.Basic VLSI Design, Douglas Pucknell, K. Eshraghian, Prentice Hall India.	
Learning Outcomes	Students should able to designed fundamental gates and customize them for specific electrical and electronics application, Should understand the fabrications processes involved in VLSI technology, Write the Hardware descriptive form of circuits, Synchronize the combinational and sequential circuits, design a static and dynamic memory cell , Understand the Programmable logics building blocks.	

Course Code: ELO 101
Title of the Course: ADVANCED DIGITALCOMMUNICATION SYSTEMS
Number of Credits: 4

Prerequisites for the course:	Graduate level understanding in basics of Electronic Communications	
Objective:	This course is intended to introduce to students into the basics of wireless systems – concepts, theory. It covers various modulation techniques, to enable the student to synthesize and analyze wireless and mobile cellular communication systems over a stochastic fading channel	

Content:	**Introduction to Mobile and Cellular Communication Systems:** Main 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.	6
	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.	8
	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.	10
	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.	09
	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,	07
	Mitigation Techniques for Mobile System: Overview of Natural and manmade external noise sources, Radiation hazards effects from base stations, Mobile and portable equipments.	04
	Diversity Techniques for Mobile Radio Systems: Dispersive channels, Space diversity, Frequency diversity,	

	Equalizer techniques **Tutorials:** 1. Study of Global Positioning system working principle. 2. Study of mobile Service providers in Goa Region. 3. Study of AIR station Bambolim, Goa. 4. Study of Distance Education Infrastructure Setup (DEITE) at Goa University. 5. Study of various interfacing of mobile set eg. Bluetooth.	04
	Total	48
Pedagogy:	lectures/ tutorials/assignments	
References/Readings	**1. Steele, R., Hanzo, L., "Mobile Radio Communication" 3rd Edition Wiley 2005.** **2. Rappaport, T.S., "**Wireless Communications: Principles And Practice, 2/E,Pearson 3. Wireless Communications (WIRELESS COMMUNICATIONS, 2ND ED, Molisch A F),Wiley	
Learning Outcomes	At the end of the course, 1.the students will be able to understand the design, specifications and the performances of various wireless communication systems 2. Apply the cellular concepts to evaluate the signal reception performance in a cellular network. 3. Apply the traffic analysis to design cellular network with given quality of service constraints. 4. Determine the appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium. 5. Analyze and design receiver and transmitter diversity techniques.	

Course Code: ELO102 **Title of the Course:** Numerical Computation and Algorithms
Number of Credits: 4

Prerequisites for the course:	Students should have a knowledge of programming	
Objective:	The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems on the computer and also Data Bases.	
Content:	**Computer Programming:**Introduction to Algorithms, Elements of Computer Programming language Basics of algorithm design, general model, Dynamic programming model, principle of optimality, backtracking models.	08 hours

	• Algorithm order and complexity. • Backtracking example. **Data Structures:** Introduction to Data Structures, Vectors and Lists, Binary Trees, Graphs, Hashing. • Implementation of Shortest path algorithm • Implementation of binary tree **Theory of Numerical programming:** Theory of numerical errors, Numerical Integration: Trapezoidal & Simpsons rule, Romberg method, Improper integrals; Numerical Solution of linear equations: Guass-Jordon elimination and Lu decomposition, Numerical Solutions of nonlinear equations: Bracketting, bisection,Secant & Regulafalsi method, Newton-Ralphson method; Numerical Solutions to Ordinary differential equations: Runge-Kutta method, Modified midpoint method, Richardson extrapolation. • Trapezoid methods, Newtons Raphson methods • Bisection and Regular falsi methods • Runge Kutta **Database:** Basic Concepts, Relational Data Model, Database Design, DBMS storage structures and access methods, Query Processing, Transaction Processing, Security & Integrity, Distributed Databases, Client Server Computing. • SQL for database • Client Server data base query **Tutorials:** 1. Implementation of Vector in C++. 2. Implementation of List in C++. 3. Implementation of minimum path algorithms in C++. 4. Simple Example of Database querying in C++. 1. Case study on the Emerging Trends in databases (Data mining).	10 hours 24 hours 06 hours
	Total	48
Pedagogy:	lectures/ tutorials/presentation/practical	
References/Readings	1. Data structures using C and C++ by Yedidyah Langsam, Moshe J Augenstein, Aaron M Tenenbaum, Prentice Hall of India, 1995 2. Data Abstraction and Problem solving in Java by Frank M Carrano, Janet J Prichard ,Addison-Wesley, 2001 3. Numerical Recipes in C, William H. Press, Brain P. Flannery, William T. Vetterling, Saul A. Teulosky, Cambridge University Press, 1990. 4. Numerical Mathematical Analysis, J. B. Scarborough, Oxford and IBM Publishing Company (1979). 5. Numerical Recipes in C: The Art of Scientific Computing by William H Press, Brian P Flannery, Saul A Teukolsky - Mathematics – 1992. 6. Fundamentals of Database Systems, 4th Edition by R Elmasri, S Navathe Addison-Wesley, 2003	
Learning Outcomes	After completing this course they will be able to use	

	numerical methods for solving a problem, locate and use good mathematical software, get the accuracy you need from the computer, assess the reliability of the numerical results, and determine the effect of round off error or loss of significance. Solve a linear system of equations using an appropriate numerical method	

Course Code: ELC 102 **Title of the Course: ELECTRONICS PRACTICALS –I**
Number of Credits: 4

Prerequisites for the course:	Should have studied graduate level basic level electronic subject. It is assumed that students have a working knowledge of passive and active components and digital circuits.	
Objective:	The hardware experiments give a student hands-on experience to design the basic digital and analog circuits, usually found in house hold appliances. The simulations experiments give understanding of the digital communications having various modulation techniques and also data correction and detection in general communication system.	
Content:	Hardware experiments 1. Design of variable voltage supply @ 2 Amps. 2. Temperature Controller using 741. 3. Design of Function Generator. 4. Design of 4-bit UP-DOWN Counter. 5. Design of Power Amplifier 10 Watts. 6. Design of Stepper driver using Monoshot & 555 Timer. Software Simulations 7. Implementation of MSK modulation and demodulation. 8. ASK, FSK, QPSK, modulation & demodulation. 9. QPSK, modulation & demodulation 10. DS-CDMA simulation. 11. Channel Coding methods. a. Convolution b. Block code 12. Error detection and correction Algorithm a. CRC b. Hamming code	
	Total	96
Pedagogy:	Presentations /assignments/self-study	
Learning Outcomes	The student will understand and should be able to handle basic equipment in house hold. Also, he will thoroughly understand the basics of communication system for modulation, data coding , error coding channel coding methods.	

Course Code: ELO181
Title of the Course: SWAYAM-I
Prerequisite/objectives/learning outcomes as provided by course on SWAYAM website.
Number of Credits: 4

SEMESTER II

Course Code: ELC 201
Title of the Course: EMBEDDED SYSTEMS DESIGNS & IoT
Number of Credits: 4

Prerequisites for the course:	Should have studied microprocessor and C programming at graduate level	
Objective:	• Architectures of Microcontroller and its programming with Interfacing various Interfaces is discussed in depth in this paper. • In this course students are going to learn how to develop apps for Android phone using SDK. • To Understand the Architectural Overview of IoT • To Understand the IoT Reference Architecture and Real-world Design Constraints • To Understand the various IoT Protocols (Data link, Network, Transport, Session, Service)	
Content:	**Architectures: Embedded system , Computer Architecture,** RISC/CISC and Harvard/Princeton Architectures, Introduction to 8-bit Micro controllers , ARM : Introduction to 32/64-bit Processors, Latest ARM ,ARM Architecture & Organization, ARM/THUMB, ARM/THUMB Instruction Set, ARM Exception Handling,Timers/Counters, UART, SPI, PWM, WDT, Input Capture, Output Compare Modes, I2C . **Interfacing:** LED, Switches, ADC, DAC, LCD **Programming** : ARM programming in Assembly and C (GNU Tools), **Introduction to Android & app development** **IoT ARCHITECTURE AND PROTOCOLS:** IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M . Introduction IoT Big Data Analytics **IOT DATA LINK LAYER & NETWORK LAYER PROTOCOLS** PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,Z-Wave, Bluetooth Low Energy,	**10** **2** **7** **3** **8** **2** **5**

	Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP **TRANSPORT & SESSION LAYER PROTOCOLS** Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT **SERVICE LAYER PROTOCOLS & SECURITY** Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols– MAC 802.15.4 , 6LoWPAN, RPL, Application Layer.	**6** **5**
Total		**48**
Pedagogy:	lectures/ tutorials/assignments/self-study/Flipped classroom	
References/Readings	1. Jivan Parab etal., Exploring C for microcontroller (Springer 2007) 2. Lipovski G. J. Single and multiple Chip Microcontroller interfacing. Prentice Hall, USA 1998. 3. Beginning Android 4 Application Development 4. Professional Android 4 Application Development Learning Android Game Programming : A Hands-On Guide to Building Your First Android Game 1st Edition 5 .Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, **"**From Machine-to-Machine to theInternet of Things: Introduction to a New Age of Intelligence**",** 1st Edition, Academic Press, 2014. 8. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet ofThings", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer 9. Vijay Madisetti and ArshdeepBahga, **"**Internet of Things (A Hands-onApproach)**",** 1st Edition, VPT, 2014.	
Learning Outcomes	• Students will be able to develop their own embedded platform using ARM • They will be able to design android application for mobiles • understand where the **IoT**concept fits and possible future trends; understand the various network protocols used in Application	

Course Code: ELO201 **Title of the Course:** OPTICAL COMMUNICATION SYSTEMS

Number of Credits: 4

Prerequisites for the course:	The Knowledge of Electro statics and electromagnetics. Also, basic understanding of analog and digital communication is preferable.	
Objective:	The paper highlights importance of optical communication over existing copper cable and microwave communication. It also gives an elaborate view of electromagnetic spectrum usage for various applications starting from telephony till satellite communication. A strong theoretical base is created to understand the difference between ray theory and wave theory approach for passage of signal in optical fibers. The estimation of noise in optical detection is discussed in detail. The paper emphasizes the industrial needs in cabling technique and type of cable used. Different techniques of optical fiber manufacturing and measuring their characteristic are discussed.	
Content:	**Light Propagation in Optical Fiber**: 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 **Fiber Optics Technology**: Glass fiber fabrication, cable design, coupling, splicing and connectors, splicing methods, connectors, fiber measurements. **Optical Sources**: LED and LDs, development of Laser diodes structures, transmitter circuits, Coupling efficiency of source to fiber. **Optical detectors**: Photodiodes, Avalanche diodes and other detectors. **Receiver sensitivity and BER**: Receiver design, Noise in detectors. **Communication System design**: System requirement, System design, Link analyses, Power budgeting. **Transmission**: TDM, Undersea fiber optics communication system , WDM and DWDM techniques	7 7 6 6 8 7 7
	Total	48
Pedagogy:	Lectures/Tutorials/Presentations /self-study	
References/Readings	1. Optical Fiber Communication by A. Selvarajan and etal TMH, .	

	2. Optical Fiber Communication by Gerd Keiser , MGH , . 3. Optical Electronics, 4th Edition by A. Yariv, HRW publication,	
Learning Outcomes	The students at the end of the paper, will have some knowledge of designing a point to point optical link for a given situation. They will also be able to choose the right type of components if an assignment of optical network design is given. The course is also useful for students who would like to join telecom industries, as many aspects of practical situation are discussed during course of study. They are also taught to monitor signal losses during course of signal transmission. The student from this course will be confident	

Course Code: ELO 202 **Title of the Course:** OPERATING SYSTEM AND RTOS
Number of Credits: 4

Prerequisites for the course:	Should have studied digital electronics at graduate level	
Objective:	This course develops to focus on concept of highlighting the various methods of improvising speed of computing machine through the operating system organization and various entity managements. Further the subject is developed to analyse the small embedded system developments through the Real Time Operating Systems for task management efficiency.	
Content:	Introduction to Computer Organization and Architecture : hardware vs. software -the virtual machine concept, concept of von Neumann architecture, hardware components and functions, trends in hardware development, system configurations and classifications. Process Description and Control: Processes, process states, processor modes, context switching, CPU scheduling algorithms, threads. Concurrency Control: Concurrent processes, critical section problem and solutions, mutual exclusion solution requirements, semaphores and monitors. Deadlocks: Characterization, detection and recovery, avoidance, prevention. Inter Process Communication: classical IPC problems and solutions, IPC techniques. The Input/Output and File Subsystem: I/O devices, controllers and channels, bus structures, 1/0 techniques (programmed, interrupt driven and DMA), I/O subsystem layers. Concepts of files and	6 hours 5 hours 5 hours 5 hours 3 hours 6 hours

	directories, issues and techniques for efficient storage and access of data. I/O and file system support for graphics, multimedia, databases, transaction processing and networking. The Memory Subsystem: Memory types and hierarchy, module level Organization, cache memory. Memory partitioning, swapping, paging, segmentation, virtual memory. The Central Processing Unit: CPU components, register sets, instruction cycles, addressing modes, instruction sets, concept of micro-programming ,Basics of RISC approach, pipelined and super-scalar approaches, vector processors and parallel processors, hardware support for the OS. μCOS case study Tutorial 1. Implementing Lower Level Shell 2. Implementing Signal in Unix 3. Hard disk partitioning in Linux	8 hours 6 hours 4 hours
	Total	48
Pedagogy:	Lectures/ tutorials/assignments/self-study	
References/Readings	1.Operating system principles, 3rd Edition,by Willian Stallings –PHI(1998) 2. Operating system concepts by Silberchatz and Galvin - Addision wesley 3. Operating system by Tanaumbuam, PHI New Delhi	
Learning Outcomes	Will able to generalize the understanding of the computing machine and various entities associated with the enhancement of the efficiency. Will able to handle the operating system management process, memory, I/O, Secondary Disk and organizations of various. Students will able to handle any operating system for process and task managements if follows the documentations of the same.	

Course Code: ELC 202 **Title of the Course:** ELECTRONICS PRACTICALS-II
Number of Credits: 4

Prerequisites for the course:	Should have studied microcontrollers and embedded system.	
Objective:	The students will handle experiments on processor and	

	controllers like 8086, 89C51, PIC and ARM controller derivatives for Input Output operation, Various communication interfaces, data acquisition, task management.	
Content:	1. Coping the memory segment using 8086 Assembler 2. Sorting of numbers using 8086 Assembler 3. Multiplication & Division using 8086 Assembler 4.LCD & LED Interfacing to ATMEL 89C52 5. 7-segment Interfacing to ATMEL 89C52 (BCD counter) 6. Display Temperature using ATMEL 89C52 7. Serial Transmission and reception PIC16F877 8. Configuring On - chip ADC PIC16F877 9. Waveform generation using I2C based Max5822 interfaced to PIC 16F877 10. Hex Keypad Interfaced to ARM controller 11. LCD & LED Interfacing using ARM controller 12. Switching of tasks using ARM controller a. OS - I using ARM b. OS - II using ARM 15. Shell programming - Web Application. 16. Shell programming - System Management 17. Shell programming - Data processing	
	Total	96
Pedagogy:	Presentations /self-study/laboratory design and implementation	
Learning Outcomes	Should able to analyze the architectures of any processor, controller. Will able to designs some application using embedded system using tasks for real time applications. Should able to handle any computing machine using shell script for computing and management.	

Course Code: ELO 281
Title of the Course: Swayam-II
Number of Credits: 4
Prerequisite/objectives/learning outcomes as provided by course on SWAYAM website

Course Code: ELO 203 **Title of the Course:** BASICS OF MEDICAL IMAGING
Number of Credits: 1

Prerequisites for the course:	NIL	
Objective:	This is a basic course to give an idea of various radiology techniques used in hospitals for imaging internal organs. While the major part of the course deals with X-ray based imaging techniques, other popular techniques such as ultrasound and Magnetic Resonance Imaging are discussed in depth. The	

	mathematical tools used for imaging analysis are also discussed briefly. Advanced techniques such as 3D imaging and Doppler methods are explained in a concise manner.	
Content:	**UNIT-I :Basic Medical Imaging :** Basics of medical imaging, X-ray, CT , Ultrasound, MRI, PET-CT, SPECT-CT, Gamma Camera, Catheterization Lab. Aspects of light imaging, convolutions and transforms, photometry lenses and depth of field, Image perception and 3D Imaging, Image acquisition, Display, Image processing operations, scanning & segmentation. **UNIT-II: Ultrasound Imaging:** Principles of Ultrasound, Basic Ultrasound instrumentation, Image Characteristics: Ultrasonic Texture, Speckle reduction, Compensation of Phase Aberration, Tissue Characterization. Imaging techniques: (A mode, B Mode, 2B, B/M, 4B , Gated Mode, 3D, 4D, M-Mode, Echocardiography) ,Doppler Methods, Image recording devices, Image artifact,	**6** **6**
Total		**12**
Pedagogy:	lectures/ tutorials/assignments/self-study/presentation/	
References/Readings	1. **Introduction to Medical Imaging**: Physics, Engineering and Clinical Applications ,Cambride 2. Medical Imaging: Principles and Practices,CRC press.	
Learning Outcomes	This course enriches a common man regarding non-invasive techniques used by hospitals and clinics to monitor the various health related issues. The course also prepares a student for higher learning in field of biomedical electronics.	

Course Code: ELO 204
Title of the Course: Data Science and Machine Learning
Number of Credits: 04

Prerequisites for the course:	Should have the knowledge of basic linear algebra and reasonable programming experience	No. of Lectures
Objective:	The objective of this course develop the fundamental knowledge of concepts related to data science and see how Data Science helps to analyze large, unstructured data with different tools	
Content:	**1. Introduction:** What is data science? Exploratory data analysis, Data Science Process, Data Case Studies **2. Types of Data:** Structured and Unstructured data, Quantitative and Qualitative data, Data levels **3. Python Structuring Data Science:** Why Python, Working with Python, Reviewing basic	03 03 03

	python **4. Visualizing Data:** Matplotlib, Bar Charts, Line Charts, Scatterplots, For Further Exploration **5. Working With Data:** Exploring One-Dimensional Data, Two Dimensions, n-dimensions, Data classes, Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction **6. Machine Learning:** Modeling, What is Machine Learning? Overfitting and Underfitting, Correctness, The Bias-Variance Trade-off, Feature Extraction and Selection **7. k-Nearest Neighbors:** Model, Curse of Dimensionality **8. Regression:** Simple Linear Regression: Model, Using Gradient Descent, Maximum Likelihood Estimation Multiple Regression: Model, Assumptions of the Least Squares Model, Fitting the Model, Interpreting the Model, Goodness of Fit, Digression: The Bootstrap, Standard Errors of Regression Coefficients, Regularization Logistic Regression: The Logistic Function, Applying the Model, Goodness of Fit, Support Vector Machines **9. Decision Trees:** What Is a Decision Tree? Entropy, The Entropy of a Partition, Creating a Decision Tree, Random Forests **10. Neural Networks:** Perceptrons, Feed-Forward Neural Networks, Backpropagation **11. Deep Learning:** The Tensor, The Layer Abstraction, The Linear Layer, Neural Networks as a Sequence of Layers, Loss and Optimization, Other Activation Functions, Softmaxes and Cross-Entropy, Dropout **12. Clustering** The Idea, The Model, k-mean, Bottom-Up Hierarchical Clustering **13. Data Science and Ethical Issues:** Discussions on privacy, security, ethics,	03 05 05 04 06 02 03 05 04 02
Total		48
Pedagogy:	Lectures/Tutorials/Assignments/Self-Study/Presentation/Practical	
Reference/Readings	1. Data Science from Scratch, First Principles with Python, 2nd Edition, Joel Grus, O'Reilly Media, Inc., 1005	

	Gravenstein Highway North, Sebastopol, CA 95472. 2. Principles of Data Science, Sinan Ozdemir, Packt Publishing, Livery Place, 35 Livery Street, Birmingham B3 2PB, UK. 3. Doing Data Science, Straight Talk From The Frontline, Cathy O'Neil and Rachel Schutt, O'Reilly. 2014, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472. 4. Programming in Python, Dr. Pooja Sharma, First Edition, BPB Publications, India	
Learning Outcomes	At the end of the course students will be able to: 1. Explain the fundamentals concepts of data science and categories of data. 2. Develop the skills to analyze the data with python programming. 3. Analyze the unstructured data using various methodologies to get meaningful information out of it.	

SEMESTER III

Course Code: ELC 301 **Title of the Course:** Signals and Systems
Number of Credits: 4

Prerequisites for the course:	Should have studied first year of M.Sc electronics	
Objective:	The objectives of this course are to develop good understanding about signals, systems and their classification; to provide with necessary tools and techniques to analyze electrical networks and systems to develop expertise in time-domain and frequency domain approaches. Also discusses different types of Filters and Its design.	
Content:	**1. Signal And Signal Processing:** Characterization and classification of signal, Typical signal Operations. **2.Discrete time signal and Systems:** Time Signal, Sequence representation, Sampling process, Simple Interconnection schemes, Correlation of Signal, Random Signal. **3.Discrete Time Fourier Transform:** Continuous Discrete-time FT, Energy Density Spectrum, Phase and Group Delays, Sampling of continuous tie signal, Low pass & Band pass Signal, Anti-Aliasing Filter design, Sample and Hold, A to D, D to A convertors, Effects of sample and hold. **4.Digital Filter Structure:** Block diagram representation, FIR, IIR filter, Allpass filter, Tunable IIR Digital filter, Digital Sin-Cosine generator. Computational complexity. **5.FIR Digital Filter Design:** Preliminary considerations, FIR Design based on windowed FS,	04 08 10 08 07

	Design of minimum phase. **2. DSP Algorithm implementation:** Structure simulation, Computation of DFT, DFT & IDFT using MATAB, Sliding DFT, Number representation, Handling overflow, Tunable digital filters. **3. Application of Digital Signal Processing:** Dual tone multi frequency tone signal Detection, Musical sound processing, Signal compression, Trans multiplexers. Tutorials: 1. History of Fourier Transform. 2. Understanding Speech Spectral Analysis Problem. 3. Understanding FFT. 4. Study of TMS Series of processors. 5. MATLAB program for generation of complex exponential sequence.	06 05
Total		**48**
Pedagogy:	lectures/ tutorials/assignments/self-study/presentation/	
References/Readings	1. Sanjit K Mitra, Digital Signal Processing: A computer Based Approach 2. Digital Signal Processing, Johnny Johnson, PHI. 3. Digital Signal Processing, Proakis, PHI.	
Learning Outcomes	Applying different signal processing algorithms to any given application. Learns about Different types FIR and IIR filters	

Course Code: ELO 301 **Title of the Course:** Digital Signals Processing
Number of Credits: 4

Prerequisites for the course:	Basic knowledge in Numerical Methods and computation at graduate level or higher.	
Objective:	This course develops concepts in designing the experiment in Matlab and Simulink.	
Content:	Students have to design the following experiments in Matlab and Simulink and plot the characteristics of the signal processing system under design. 1.Filters a. Lp norm b. Ensemble averaging Filters c. Exponential moving average systems d. Median filter e. FIR 2.Understanding and implementation of aliasing effect. 3.Oscillators a. Design using Van der Pol's equation	 12 05 07

	b. Lorentz oscillators systems c. Gaussian oscillators systems 4.FFT and DFT:design and implementation of DFT and FFT based algorithms, and their application in communication. 5. Image processing a. Interpolations b. Pattern recognition using PCA 6.Simulink a. Transfer function design and study for impulse and finite sequence. b. Convolution	05 05 09 05
Total		48
Pedagogy:	lectures/ self-study/presentation/lab courses	
Learning Outcomes	• Student learn how to use the advanced mathematical tools how to apply them for signal processing. • Student can plot the signals in both time domain and transform domains using MATLAB • Students also learns to uses SIMULINK tool to model his/her design • Learns Image processing algorithms PCA etc.	

Course Code: ELO 302
Title of the Course: INSTRUMENTATION & CONTROL THEORY
Number of Credits: 4

Prerequisites for the course:	Graduate level knowledge in analog and digital electronics, Basics of differential equations.	
Objective:	Various principles of transduction and actuator are discussed in this course. The important parameters used in instrument characterization are also explained. Types of error committed by a user and how to deal with them are explained with examples. Also, various standards followed for accurate measurement are discussed in depth. The techniques used to convert analog data into digital domain and its analysis and storage are also discussed in this course. How a PID controller is tuned for a given application is also discussed in this paper. Few important instruments such as Oscilloscope, spectrum analyzers, wave analyzers, Lock in amplifiers are described in depth	
Content:	**Introduction:** Basic Concepts of measurements, calibrations and standards. Transducers (Types and parameters) and Sensors: Displacement, strain, vibration, Pressure, Flow,Temperature, Force and Torque (linearity, accuracy, precision, bandwidth, repeatability) **Amplification**: Simple ended, Differential and	7

	Instrumentation amplifier. **Sampling:** An Anti-aliasing, Multiplexers, Sample and Hold, Track and Hold. **Computer Interfaces:** Serial (RS-232), Parallel, GPIB (IEEE-488), Universal Serial Bus (USB) **Display Devices:** Review of LED, LCD, CRT devices, segmental and dot matrix displays. **General purpose test equipments:** CRO, Digital storage oscilloscope, Digital voltmeter, Wave Spectrum analysis, Lock-in-amplifiers, Pulse generators and waveform generators, **Control System**: Types of control system - open loop, closed loop, linear, non-linear, continuous, discrete, frequency and time response, open loop motor control, DC motor phase control,PD,PI,PID Tutorials: 1. Study of Open loops control System. 2. Electronics Chocks. 3. Design of On/Off temperature controller using thermistor sensor. 4. Study of SEM.5. Study of Scanning Probe technique.	5 5 4 7 10 10
Total		48
Pedagogy:	Lectures/Assignment , Presentation	
References/Readings	1. Industrial Control Electronics – John Webb, Kevin Greshok, Merrill Publications, . 2. Elements of Electronic Instrumentation and Measurement, Joseph J. Carr, Prentice Hall India. 3. Modern Electronic Instrumentation and Measurement Techniques, Albert Helfnick, William Cooper, PHI 4. Instrumentation Measurement by Northrop CRC 2001	
Learning Outcomes	This course is appropriate for the students who would like to make his career in industries. The features of various networks taught in this course will enable him/her to guide an industry for choosing an appropriate instrumentation network and types of interfaces he can adopt for automation of sophisticated instruments used in quality control and analysis. The course empowers a student who is likely to go for higher studies in electronics and Instrumentation technology.	

Course Code: ELC302 **Title of the Course:** Electronics Practical III

Number of Credits: 4

Prerequisites for the course:	Should have knowledge in microcontroller and embedded systems	

Objective:	The course gives hands on experience on TMS 320 DSP, Altera NIOS II and National Instruments Platform	
Content:	1. Design of S/C circuit for Strain gauge /Glucose strip @ 3.3V. 2. Design of S/C circuit for Thermistor sensor @ 3.3 V and interfacing with ARM. 3. FFT using TMS 320. 4. Convolution using TMS 320. 5. Analysis of frequency components using Spectrum Analyzer 6. VHDL implementation for the Multiplexer & Demultiplexer 7. VHDL Implementation for Encoder & Decoder 8. VHDL implementation for the Counter. 9. Verilog implementation for the Memory Module. 10. Verilog implementation for the Latch. 11. Display Hello world and blinking Led's using NiosII soft core 12. Matrix Manipulation on NIOSII Core (Multiplication, determinant, Inverse, Transpose) 13. Android (two experiments) 14. NI ELSVIS(two experiments) 15. Obstacle Avoidance using 89V52 based Robot 16. Obstacle detection for varying range using 89v52 based Robot 17. Line follower using 89v52 based Robot	
Total		96
Pedagogy:	Assignment , Presentation and Laboratory work	
Learning Outcomes	• On completing this couse they are in a position to design signal conditioning circuit, • also they are exposed to Altera FPGA by implementing various digital circuits using VHDL and Verilog. • Student themselves will be able to develop an android app. • Can handle a NI ELVIS board to implement and testing any circuit.	

Course Code: ELO 381
Title of the Course: Swayam-III
Prerequisite/objectives/learning outcomes as provided by course on SWAYAM website.
Number of Credits: 4

Course Code: ELO303 **Title of the Course:** Digital System Design Using HDL
Number of Credits: 4

Prerequisites for the course:	Should have studied digital electronics at graduate level.	
Objective:	This course develops concepts in Principles of Combination and Sequential logic design, VHDL and Verilog.	
Content:	**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 n-Cubes 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, **2. Combinational Logic Design Principles:** Switching Algebra, Combinational-Circuit Analysis, Combinational-Circuit Synthesis, and Timing Hazards. **3. Hardware Description Languages:** HDL-Based Digital Design, ABEL Hardware Description Language, The VHDL Hardware Description Language, The Verilog Hardware Description Language, **4. Combinational Logic Design Practices:** 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 . **5. 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, ABEL Sequential-Circuit Design Features ,Sequential-Circuit Design with VHDL , Sequential-	07 08 06 06 09

	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 **6. Memory, CPLDS, AND FPGAS** Read-Only Memory, Read/Write Memory, Static RAM, Dynamic RAM, Complex Programmable Logic Devices, Field-Programmable Gate Arrays **Tutorials:** 1. Design flow for the simple microprocessor in HDL 2. Study and compares types of RAMS. 3. Design of GRAY code circuit. 4. Study of ALTERA PLD's 5. Study of XYLINX PLD's. 6. Studying WEB Pack Xilinx tool.	12
Total		48
Pedagogy:	lectures/ tutorials/assignments/self-study	
References/Readings	1. Digital Design Principles and Practices, by John F. Wakerly, Prentice Hall's Fourth Edition. 2. Digital Logic Applications & Designs by John M. Yarbough, CWS Publishing Co. Division of Thomson Learning, 3. Giovanni De Micheli, "Synthesis and Optimization of Digital Circuits," Tata McGraw-Hill, 2003. 4. Srinivas Devadas, Abhijit Ghosh, and Kurt Keutzer, "Logic Synthesis," McGraw-Hill, USA, 1994. 5. Neil Weste and K. Eshragian,"Principles of CMOS VLSI Design: A System Perspective,2nd edition, Pearson Education, 2000. 6. Kevin Skahill, "VHDL for Programmable Logic," Pearson Education, 2000. M.N.O. Sadiku, Elements of Electromagnetics 2nd Edition) , Oxford University press, 1995.	
Learning Outcomes	Explains Principles of Combination and Sequential logic design and HDL.	

Course Code: ELO 304 **Title of the Course:** EDA Tools

Number of Credits: 4

Prerequisites for the course:	Should have studied Digital Communication Systems	
Objective:	This course develops concepts in Programming with different types of EDA Tools	
Content:	Study of JTAG, Modelsim Syntax study. 1. Study of Phases of Quartus compilations.	4

	2. Study of phases of ISE compilations 3. Testing logic using ChipScope-I. 4. Testing logic using ChipScope-II 5. Parallel implementation of CRC. 6. Serial implementation of CRC. 7. FIFO implementation 8. pulse stretcher 9. Test bench using Modelsim-I 10. Test bench using Modelsim-I 11. Test bench using Modelsim-I 12. Test bench using Modelsim-I	4 4 4 4 4 4 4 4 4 4 4 4
Total		48
Pedagogy:	Assignments/self-study/Lab courses/FLIPPED CLASSROOM	
References/Readings	1. Design through Verilog HDL By T. R> Padmanabhan & Sundari. IEEE press, Wiley Interscience. 2. http://www.xilinx.com/itp/xilinx7/help/iseguide/html/ise_fpga_design_flow_overview.htm 3. Hands on experience on altera development board by J.S.Parab,etal: Springer Netherland 2018(ISBN 978-81-322-3769-3)	
Learning Outcomes	The Student will be able to use different types of EDA tools and learn programming with these tools.	

Course Code: ELO 305 **Title of the Course:** Industrial Internship
Number of Credits: 1

Prerequisites for the course:	Should have graduate level knowledge of Electronics	
Objective:	This course develops concepts in industrial training, preparing seminars and working on short term projects	
Content:	**Industrial training and Seminar:** A student has to undergo Industrial training equivalent to one credit for the period of minimum 1 month in the respective Electronics industries / Research Laboratory anywhere in India. Each student has to give a power point presentation on the industrial internship which they had undergone	24
Pedagogy:	Self-study/presentation	
Learning Outcomes	1. The Student will be exposed to the different kinds of working environments in electronic industries. 2. Will be able to understand industrial flow and make a documentation.	

SEMESTER IV

Course Code: ELC 401
Title of the Course: Laser System Engineering
Number of Credits: 4

Prerequisites for the course:	Graduate level knowledge in Electronics/Physics	
Objective:	At the end of the course the student is expected to know the difference between ordinary light and light emitted by a laser device. Which are different method used for excitation of laser devices? Why four level lasers are more efficient as compared to three level? The theory to explain the generation of stimulated emissions. Actual laser systems used in industry and examples most powerful lasers in the world. Application of lasers in medical, civil and defense areas.	
Content:	**Optical Resonators**: Energies in resonator, Febry-Perot Etalon , Febry-Perot Etalon as Optical Spectrum Analyzer, Mode Stability Criteria , Resonance Frequency of Optical Resonator,Unstable Resonator **Interaction of Radiation with Atomic System:** Spontaneous transmission between Atomic layer, Homogenous and In-Homogeneous broadening , Line shape functions, Stimulated transmission , Absorption and amplification , gain saturation in Homogenous media . **Theory of Laser Oscillator:** Febry Perot Laser , Three and Four Level Laser , Power in Laser Oscillator, Optimum Light coupling , Multimode Laser Oscillator and Mode Locking Methods of Mode locking , Pulse length Measurements , Q-Switching , methods of Q-Switching . **Laser Systems:** Pumping and laser Efficiency, Ruby Laser, Flash Pumping ,Nd-YAG Laser , Nd Glass Laser , Threshold for CW and Pulse operation , He-Ne Laser , CO2 Laser , Ar-Ion Laser , Excimer Laser , Dye Laser. **Non –Linear Optics:** Origins of Non-Linear Polarization, relation between induced Polarization **Interaction of Light and Sound:** Scattering of Light by Sound, RamanNath and Bragg diffraction , Defration of light by Sound , Intensity modulation . **Optical Communication:** Advances in optical Communication, Optical Network. Tutorials: 1. Understanding Diffraction of Laser Light using grating 2. Comparison of resolving power of Prism and Grating. 3. Focusing of Laser Light.	9 8 8 7 4 6 6

	4. Collimation of Laser Light. 5. Study of Raman Laser system.	
Total		48
Pedagogy:	Lectures/presentation/assignments	
References/Readings	1. Optical Electronics, 4th Edition by A. Yariv, HRW publication, . 2. OptoElectronbics , by Ghatak and Tyagarajan TMH Publication .	
Learning Outcomes	The student has sufficient knowledge of lasers for applications involving medical treatment as well as defense needs. They will have a full knowledge of classification of lasers and its usage. Now a days, most of the industries use high power lasers as a tool, the student with this knowledge will be handy in guiding the work force for safe use of laser.	

Course Code: ELC 402
Title of the Course: ELECTRONICS PRACTICALS - IV
Number of Credits: 4

Prerequisites for the course:	Should have studied EDA Tools .	
Objective:	• The course is intended to introduce to the students with LabVIEW and SPEEDY 33 Boards and MYRio BThoard • Also there are few labs on Altera DE2 Board using NIOS II soft core Prosessor.	
Content:	**1.** Reading from flash using DE2 board **2.** LCD and 7 segment Interfacing using DE2 board **3.** PS/2 Mouse Interface on DE2 board **4.** UART Interface using DE2 board **5.** Blinking of LEDs using RTOS on DE2 Board. **6.** KEY pad and ADC interfacing using RTOS **7.** Echo implementation on speedy33 kit(lab view) **8.** Reverberation implementation on speedy33 kit(lab view) **9.** IOT (3 experiments) **10.** My RIO(3 experiments)	
Total		96
Pedagogy:	Presentation and Laboratory works	
Learning Outcomes	After completion of this course on practical they will be able to develop and design some applications based on SPEEDY 33 using LABView , MYRio, Altera DE2 Board	

Course Code: ELO 401
Title of the Course: PROJECT
Number of Credits: 8

Prerequisites for the course:	Decided by DC at the beginning of the IIIrd semester based on the performance at M.Sc part-I	
Objective:	This course develops concepts design modules/ instrumentation as required by industry/ institution/ departments	
Content:	This course is basically to utilize the knowledge they have acquired during the course of study and apply them for designing a gadget/interface/module required for an electronic industry/ department/ Institution. The progress of the project is periodically monitored by an guide and department council.	192
Pedagogy:	Self-study/presentation	
Learning Outcomes	1. The Student will be exposed to the different kinds of working environments in electronic industries. 2. Will be able to understand industrial flow and make a dissertation.	

Course Code: ELO 481
Title of the Course: Swayam-IV
Prerequisite/objectives/learning outcomes as provided by course on SWAYAM website.
Number of Credits: 4

Course Code: ELO 402 **Title of the Course: Nanoelectronics and Nanosystems**
Number of Credits: 4

Prerequisites for the course:	The students should have a working knowledge of electronics and instrumentation at graduate level	
Objective:	This course develops concepts in Microelectronics, Biological Networks, Bio and Molecular Electronics and Nanoelectronics.	
Content:	**Introduction:** Development of microelectronics; **Potentials of Silicon Technology; Basics of Nanoelectronics,** some physical fundamentals, basics of information theory; **Biology Inspired Concepts**.- Biological networks, Biology Inspired Concepts; **Bio-chemical and Quantum-Mechanical Computers**.-	05 05 05 06

	DNA computer ,Quantum computer; **Parallel Architectures for Nanosystems**. Architectural principles, Architectures for parallel processing; **Softcomputing and Nano electronics**.- methods of soft computing, characteristics of neural networks in nanoelectronics; **Quantum Electronics;** Bio and Molecular Electronics.- Bio electronics ,molecular electronics; **Nanoelectronics with Tunneling Devices**; Single Electron Transistor (SET); Nanoelectronics with Superconducting Devices; The Limits of Integrated Electronics Tutorials: 1. Laser tweezers. 2. Study of AFM. 3. Study of STM.	06 06 08 07
Total		48
Pedagogy:	lectures/ tutorials/assignments/self-study/presentation/	
References/Readings	**1.** Nanoelectronics And Nanosystem By K. Goser , P Glosekotter & J. Dienstuhl Springer **2.** Introduction to Nanoelectronics Science, Nanotechnology, Engineering, and Applications By Vladimir V. Mitin etal ; From Cambridge **3.** Handbook of Nanoscience, Engineering, and Technology, Second Edition by William A. Goddard CRC.	
Learning Outcomes	At the end of this course students will be able to apply the concepts studied in this paper to practical reality .	

Course Code: ELO 403 **Title of the Course: Pharmaceutical Instrumentation**
Number of Credits: 4

Prerequisites for the course:	Should have graduate level knowledge of Instrumentation.	
Objective:	This course develops concepts in Spectrometric and Separative Methods and Electron Microscopy	
Content:	**Introduction to Chemical Instrumental Analysis:** advantages over classical methods, classification, various units used in chemical analysis. Introduction to Electroanalytical methods, potentiometry, voltammetry, coulometry.	05 09

	Spectrometric Methods-I: Laws of Photometry, Instrument components, UV-visible instrument component, photo colorimeters, single and double beam instruments, various types of UV-visible spectrophotometers. Atomic absorption spectrophotometer: Principle, working, hollow cathode lamp, atomizer, back-ground correction. **Spectrometric Methods-II:** IR spectroscopy: Principle, IR sources, IR detectors, dispersive and Fourier , Transform IR spectroscopy. Atomic Emission Spectroscopy: Principle, types, Flame photometer, DC arc and AC arc excitation, plasma excitation. X-ray spectrometry: Instrumentation for X-ray spectrometry, X-ray diffractometer: Bragg's law **Spectrometric Methods-III:** Fluorimeters and Phosphorimeters: Principle, spectrofluorimeters, spectrophosporimeter, Raman effect, Raman spectrometer, Nuclear Magnetic Resonance (NMR) spectrometry: Chemical shift, principle, working of NMR, FT-NMR Miscellaneous Instruments: Gas analysers: CO, CO2, Hydrocarbons, O2, NOx **Separative Methods:** Chromatography: Classification, Gas chromatography: principle, constructional details, GC detectors, High Performance Liquid Chromatography (HPLC): principle, constructional details, HPLC detectors **Electron microscopy:**TEM & SEM- principles, instrumentation and analysis, scanning tunneling microscopy, atomic force microscopy, principles, instrumentation and analysis- applications **Tutorial**: 1. Study of filter photometer. 2. Study of UV-visible spectrophotometer. 3. Study of ESR	09 08 07 10
Total		48
Pedagogy:	lectures/ tutorials/assignments/presentation	
References/Readings	**1.** Instrumental Methods of Analysis, Willard, Merritt, Dean, Settle, CBS Publishers & Distributors, New Delhi, Seventh edition. **2.** Instrumental Methods of Chemical Analysis, Galen W. Ewing, McGraw-Hill Book Company, Fifth edition **3.** Introduction to Instrumental Analysis, Robert D. Braun, McGraw-Hill Book Company. **4.** Principles of Instrumental Analysis, Skoog, Holler, Nieman, Thomson brooks-cole publications, 5th edition	
Learning Outcomes	A student crediting this course will be comfortable	

	with use of analytical instruments used in pharmaceutical industries and laboratories. They can join industries in Quality Control divisions.	

Course Code: ELO 404 **Title of the Course:** Communication and Technical Skills

Number of Credits: 4

Prerequisites for the course:	Should have graduation in any science stream	
Objective:	This course develops the ability to work in group, to face interviews and to give presentations	
Content:	This course has self-study module where students will be assigned case studies. The students are supposed to gather the required subject materials by way of visiting the factories/ industries/ Institutions physically or through their website, and prepare a documentation, The documentation will be discussed in Group discussion wherein the skills of the student in Management & Communication will be evaluated by DC. The wattage of the evaluation is as follows • Group discussion in topic related to electronics (25%) • Answer paper in the area of communication skills (25%) • Has to write /compile technical papers & present (25%) • Modelling of electronics systems (25%)	
Pedagogy:	lectures/ tutorials/assignments/self-study	
References/Readings	1. Essentials of Technical Communication Sunil Gokhale 2. Communication Skills By Leena, Sen, Prentice Hall of India. 3. http://owl.english.purdue.edu/; 4. http://owl.english.purdue.edu/workshops/hypertext/	
Learning Outcomes	The student will gain experience and confidence to present themselves fearlessly at interviews .The students will also be prepared to write technical papers and present them in the conferences.	