Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Syllabus for First and Second Year of PG Program in Electronics & Telecommunication Engineering 2020 Iteration

Nomenclature of the Courses

BSC	Basic Science Course
SBC	Skilled Based Course
ABL-SATVA	Self- Accomplishment Through Various Activities
ABL-SEVA	Social Empowerment Through Various Activities
PC	Program Core
PE	Program Elective
MLC	Mandatory Learning Course
OE	Open Elective
HSSME	Humanities, Social Science, Management Elective

Abbreviations

L	Lecture Hour	O	Other Work (Self Study)
T	Tutorial Hour	E	Total Engagement in Hours
P	Laboratory Hour	C	Credit Assigned

Sem I								
No	Type	Course	L	T	P	O	E	C
1	PC	Advanced Digital Signal Processing	3	0	0	5	8	3
2	PC	Embedded and Internet of Things (IOT)	2	0	2	5	8	3
3	PC	Next Generation Network	3	0	0	5	8	3
4	PE	Program Elective-I	2	0	2	3	7	3
5	SBC	Programming Lab *	0	0	4	3	7	2
6	SBC	Digital Image and video processing Lab	0	0	4	3	7	2
7	HSSME	HSS-I	2	0	0	3	5	2
8	SBC	Writing Skills	1	0	2	2	5	2
		TOTAL	13	0	14	29	55	20

SUMMER TERM				
No	Type	Course	E	C
1	MLC	Constitution of India	50	NC
2	SBC	Seminar (Based on Literature Survey)	50	2
3	SBC	Selling and Negotiation Skills	100	2
		TOTAL	200	3

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SEM - I

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Advanced Digital Signal Processing	3	0	0	5	08	3	0	0	3
EC501		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	-		-		-		-	

Pre-requisite Course Codes, if any : Signals and Systems, Digital Time Signal Processing	
Course Objective: To develop advanced mathematical foundation of system and design digital filters	
Course Outcomes (CO): At the End of the course students will be able to	
EC501.1	Design of multirate DSP systems.
EC501.2	Design optimum linear filter and prediction.
EC501.3	Implement adaptive filters for a given application.
EC501.4	Apply the techniques of power spectrum.
EC501.5	Apply Signal processing tools to bio-medical signal processing.
EC501.6	Apply Digital signal processing at block level.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC501.1			
EC501.2			
EC501.3			
EC501.4			
EC501.5			
EC501.6			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3
EC501.1			
EC501.2			
EC501.3			
EC501.4			
EC501.5			
EC501.6			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Multi rate Digital Signal Processing**:	1,2	**10**
	1.1	Decimators and Interpolators, Sampling rate conversion, multistage implementation of sampling rate conversion		
	1.2	Poly phase realization filters, QMF, digital filter banks, Applications in subband coding.		
2	**Title**	**Linear prediction & optimum linear filters**:	1,2	**8**
	2.1	Stationary random process, forward-backward linear prediction filters, solution of normal equations,		
	2.2	AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.		
3	**Title**	**Adaptive filters :**	1,2	**8**
	3.1	Applications, Direct form FIR Filters- LMS algorithm		
	3.2	Direct form Filters- RLS algorithm, Lattice-ladder filter		
	3.3	Adaptive channel equalization Adaptive echo canceller, Adaptive noise cancellation		
4	**Title**	**Power Spectrum Estimation**:	1,2	**10**
	4.1	Estimation of Spectra from Finite-Duration Observations of Signals, Periodontal, Use of DFT in power Spectral Estimation.		
	4.2	Nonparametric Methods for Power Spectrum Estimation, Bartlett, Welch and Blackman, Tukey methods, Performance characteristic and Computational requirement. Parametric Methods for Power Spectrum Estimation, Yule-Walker, Burg, Unconstructrained Least Squares and Sequential Estimation Methods for Auto-Regressive (AR) models, Moving Average(MA) and ARMA Models		
	4.3	Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation		
5	**Title**	**Application of Digital Signal Processing to Biomedical Signal Processing**	1,2	**6**
	5.1	ECG pre-processing, QRS template, QRS detection methods, performance measure for QRS detection		
	5.2	Adaptive removal of ocular artifacts from human EEGs-Methods for removal and control of ocular artifacts		
6	**Self Study**	Application to Radar, introduction to wavelets, application to image processing, design of phase shifters, DSP in speech processing	1,2	
			Total	**42**

Text books:

Sr. No	Title	Authors	Publisher	Year
1	Digital signal processing: Principles, Algorithm and Applications	J.G.Proakis and D.G.Manolakis	4th Edition, Prentice Hall	2007
2	Multirate Digital Signal Processing: Multirate Systems - Filter Banks – Wavelets	N. J. Fliege	1st Edition, John Wiley and Sons Ltd	1999

References:

Sr. No	Title	Authors	Publisher	Year
1	Multirate and Wavelet Signal Processing	Bruce W. Suter	1st Edition, Academic Press	1997.
2	Statistical Digital Signal Processing and Modeling	M. H. Hayes	John Wiley & Sons Inc.	2002
3	Adaptive Filter Theory	S.Haykin	4th Edition, Prentice Hall	2001
	Statistical and Adaptive Signal Processing	V.K. Ingle and S.M.Kogon	McGraw Hill	2000

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Embedded and Internet of Things (IoT)	2	0	2	5	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
EC502		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	Microprocessors and Microcontrollers, Computer Organization and Architecture, Operating Systems
Course Objective: Imparting the detailed architectural features of ARM Cortex along with integrated peripherals and programming and RTOS. To impart the knowledge of IoT fundamentals with its management methods with applications	
Course Outcomes (CO): *At the End of the course students will be able to*	
EC502.1	Comprehend various advanced embedded architectures and programming models
EC502.2	Compare and contrast various ARM architecture series
EC502.3	Comprehend ARM Cortex M architecture with its integrated peripherals with its programming
EC502.4	Analyze various scheduling algorithms and various inter process communication techniques in RTOS (Free RTOS)
EC502.5	Analyze and partition the given system into hardware and software with its co-design.
EC502.6	Describe Internet of Things and its components and perform IoT system management

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC502.1			2
EC502.2			2
EC502.3	2	3	3
EC502.4			3
EC502.5	3		2
EC502.6			3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2
EC502.1		
EC502.2		
EC502.3		
EC502.4		
EC502.5		
EC502.6		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
			✓		

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Embedded Architectures**		2
	1.1	Architectures of Embedded Systems	1,2	
	1.2	Programming models for Single-Core and Multi-Core architectures	1,2	
2	**Title**	**ARM Architecture**		5
	2.1	Differences among ARM7, ARM9 and ARM11 architectures	2	
	2.2	Generic architecture concepts of ARM Cortex Series (A, R and M)	1,2	
	2.3	ARM Cortex M3- STM32Fxxx –Detailed Architecture	3	
	2.4	STM32 – Integrated peripherals (ports, timers, adc, dac, serial ports, I2C, interrupts)	3	
3	**Title**	**Real Time Operating Systems**		6
	3.1	RTOS generic architecture	4,5	
	3.2	Process and Scheduling Systems with various algorithms	4,5	
	3.3	Free RTOS Task Management and Real Time Scheduling	4,5	
	3.4	Free RTOS- Inter Task Communication, Pipes, Semaphores, Message Queues, Signals, Sockets	4,5	
4	**Title**	**Software/ Hardware Co Design**		6
	4.1	Introduction to Hardware/Software Co-design, driving factors, co-design space, dualism, modeling, concurrency and parallelism	6	
	4.2	Design principles in System On Chip (SoC) Architecture	6	
	4.3	On Chip busses, Hardware/software interfaces	6	
5	**Title**	**Introduction to IoT**		9
	5.1	Definition, Characteristics, Physical and Logical Designs, IoT Protocols, IoT Communications Models and API, IoT Enabling Technologies, IoT Levels and Deployment Templates, IoT Examples, M2M	7	
	5.2	IoT System Management: SNMP, Network Operator Requirements, NETCONF, YANG	7	
	5.3	IoT Platform Design Specifications: Requirements, Process, Domain Model, Service, IoT Level, Function, Operational view, Device and Component Integration, application Development	7	
6	**Self Study**	IoT supported hardware platforms and applications RTOS signal and image processing applications RTOS control system applications and fault tolerance applications Embedded wireless communication- GPS, GSM, Zigbee with data processing		
			Total	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Model any linear and non linear Signal
2	Model behavior of any active/Passive Component
3	Implement Real-time Low pass/High Pass filter
4	Implement Closed-Loop Control System
5	Implement FFT/DFT/Convolution algorithm
6	Configure and deploy the MCU board as a web server (HTTP)
7	Publish data from a device to a cloud platform (MQTT)
8	Implement Machine to Machine (M2M) communication with MCUs as client and server
9	Implement Real-time scheduler
10	Implement IoT Application

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Embedded System design: A unified Hardware/Software Introduction		Frank Wahid and Tony Givargis	**John Wiley Publication**	**2001**
2	ARM System Developer‟s Guide Designing and Optimizing System Software	**First**	Andrew N. Sloss, Dominic Sysmes and Chris Wright	**Elsevier Inc Morgan Kaufmann**	**2004**
3	Medium-density performance line ARM®-based 32-bit MCU with 64 or 128 KB Flash, USB, CAN, 7 timers, 2 ADCs, 9 com.	----------	----------	**Interfaces – STM Datasheets**	--------
4	Using the FreeRTOS Real Time Kernel -a Practical Guide- Cortex-M3 Edition	**Third**	Richard Barry	**McGraw-Hill**	**2010**
5	Embedded Linux Primer: A Practical Real-World Approach	**Second**	Christopher Hallinan	**Pearson Education Prentice Hall**	**2010**
6	A practical introduction to Hardware/Software Codesign	**Second**	Patrick R Schaumont	**Springer Publication**	**2013**
7	Internet of Things-A Hands-On Approach	**First**	Arshdeep Bagha and Vijay Madisetti	**Universities Press**	**2015**

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Communicating Embedded Systems: Network Applications	**Second**	Francine Krief	**Wiley-ISTE**	**2010**
2	Embedded System Design	**Second**	P Marwedel	**Springer Publications**	**2011**

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Next Generation Network	3	0	0	5	8	3	0	-	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
EC503		Theory		75		75		150		300
		Laboratory		-		-		-		-

Pre-requisite Course Codes, if any.	Computer Networks, Wireless communication
Course Objective: The course is designed to provide technical features, applications and design considerations of new and emerging network technologies.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC503.1	Describe technical features and design considerations of the next generation networks.
EC503.2	Apply the concept of convergence of service
EC503.3	Identify the NGN services in business-oriented aspects
EC503.4	Demonstrate technologies for next generation network
EC503.5	Design a network with good capacity and efficiency

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC503.1			
EC503.2			
EC503.3			
EC503.4			
EC503.5			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3
EC503.1			
EC503.2			
EC503.3			
EC503.4			
EC503.5			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to Next generation Network and ITU standards**	1	6
	1.1	Introduction Evolution of public mobile services - Main drivers to Next Generation Networks – NGN, ITU NGN standards.		
	1.2	All-IP network concept for, 3 Numbering, naming and addressing for all NGN, NGN control architectures and protocols, Transport Stratum, Service Stratum , Service Management, Application Functions. Wireless NG Technologies, Bluetooth, Zigbee, WiFi etc.		
2	**Title**	**IMS and Convergent Management IMS Architecture -**	2,3	10
	2.1	IMS services, QoS Control and Authentication, Network and Service management for NGN, IMS advantages		
	2.2	Next Generation OSS Architecture - standards important to OSS architecture, Information framework, OSS interaction with IMS, NGN OSS function/ information view reference model, DMTF CIM,Push to Talk over Cellular (PoC) Service, MS-Based FMC Service.		
3	**Title**	**NGN Services: Technology, Business Aspects**	2	8
	3.1	VoIP, IPTV, rich multimedia, future web, Quality of Service (QoS), Quality of Experience (QoE) in NGN		
	3.2	Control and Signaling protocols for NGN, NGN security, Service convergence, Business, and regulatory aspects of NGN		
4	**Title**	**MPLS and VPN Technology**	5	10
	4.1	MPLS &QoS, MPLS services and components – layer 2 VPN, layer 2 Internetworking, VPN services, signaling, layer 3 VPN – Technology overview, Remote Access, and IPsec integration with MPLS VPN.		
	4.2	MPLS multicast, IPv6 and MPLS - Technology overview, Future of MPLS – Integrating IP and optical networks, Future Layer2 layer3 services		
5	**Title**	**NGN Management and future Evaluation**	2,3	8
	5.1	Configuration, Accounting, performance, security, case study for MPLS, Future enhancements – Adaptive self-healing networks.		
	5.2	Transition of IP networks to NGN, Future packet-based network (IPv6 NGN), NGN business challenges, NGN evaluation.		
6	**Self-Study**	Software Defined Networks (SDN) & NFV, Network Automation and Containerized NFV, IMS Advantages, NEXT GENERATION OSS ARCHITECTURE, Services Implemented on NGN		6*
			Total (*Not Included)	**42**

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Next Generation Network -A Complete Guide		Gerardus Blokdyk	5STAR Cooks	
2.	Next generation Telecommunication Networks, Services and Management		Thomas Plavyk	Wiley& IEEE Press Publications	
3.	MPLS and Next Generation Networks: Foundations for NGN and Enterprise Virtualization		Robert Wood	CISCO Press	

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Next Generation Network Services	--	Neill Wilkinson	John Wiley Publications	2002
2	Next Generation Networks	--	Monique J. Morrow,	CISCO Press	2007
3	IP-Based Next-Generation Wireless Networks: Systems, Architectures, and Protocols	--	Jyh- Cheng Chen and Tao Zhang-	Wiley	-
4	Next Generation Wireless Systems and Networks	--	Hsiao – Hwa Chen, Mohsen Guizani	Wiley	-

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Millimeter Wave Technology	2	0	2	3	7	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC511		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Electromagnetic Wave Propagation
Course Objective:	
Course Outcomes (CO):*At the End of the course students will be able to*	
EC511.1	Calculate mmwave parameters for a system
EC511.2	Evaluate usage of active devices as amplifiers and sources.
EC511.3	Justify usage of system based on noise calculation and link budgeting
EC511.4	Design guiding structures, antennas and passive components for mmWave propagation

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC511.1	2	1	1
EC511.2	2	1	1
EC511.3	2	1	1
EC511.4	2	3	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2
EC511.1	1	1
EC511.2	1	1
EC511.3	1	1
EC511.4		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Millimeter Wave Technology**	1,2	04
	1.1	Millimeter Wave Bands, Attenuation, Advantages and Disadvantages, Applications.		
	1.2	Phase and Group velocity, Slow and Fast Waves, Skin depth, Boundary Conditions, mmWave Challenges, Dielectric Properties at mmWave and terahertz frequency, material properties, losses		
2		**Guiding Structures**	1,2	06
	2.1	Guiding Structures at mmWave**:** Hollow waveguide (Rectangular & Circular), planar transmission line.		
	2.2	Quasiplanar transmission line, Dielectric Integrated lines, H and groove guided structures, Coupled lines, CPW, SIW wave modes, microwave connectors, rectangular cavity resonator, Multipaction Effect		
3		**Millimeter wave Antennas& Components**	1,2	08
	3.1	Antenna Parameter, Printed mm Wave Antenna, Waveguide slot array, on chip antenna, Loop Antenna, Circuit Integration, Packaging, Leaky Wave Antenna, Radiation Pattern.		
	3.2	Dielectric Resonator, Filters, Determination of Q, Power Divider, Coupler, Terminators, Adaptors, Excitation of SIW,		
4		**Millimeter Wave Devices**	1,2	04
	4.1	Solid state devices and microwave tubes, HBT, Schottky Diode, P-I-N Diode, TEDs, Gunn Diode, Avalanche Transit Time Devices, Switches.		
5		**Millimeter Wave Systems**	1,2	06
	5.1	Noise & Link Budget: mmWave propagation, Friis Transmission equation, Link Budget, Digital modulation and bit error rate, channel performance, types of noise		
	5.2	Receiver Noise Temperature, Noise Bandwidth, Noise Factor, Trans receiver architecture.		
			Total	**28**

Sr. No	Title of the Experiment
1	Introduction to CAD
2	Design of 30 GHz planar antenna using CAD
3	Design of 30 GHz waveguide using CAD. Observe the mode.
4	Design of mmWave based SIW.
5	Design of mmWave filter.

6	Design of Leaky Wave Antenna
7	Calculate link budget for a given system using python/Matlab
8	Study of effect of rain fade on mmwave propagation using CAD
9	Design of slot array waveguide
10	Implementation of mmwave based published paper

Text Books

Sr. No	Title	Authors	Publisher	Year
1	Millimeter Wave Wireless Communications	Theodore S. Rappaport	Prentice Hall Communications Engineering and Emerging Technologies	2014
2	Millimeter Wave Communication Systems	Huang K	Wiley	2015

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Fundamentals of Data Science	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC521		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: The course is designed to provide conceptual understanding of Data Science	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC521.1	To Examine applicability of statistical and probability and linear algebra within Data Science.
EC521.2	To analyze the predictive and descriptive models.
EC521.3	To experiment with different data handling operations through modeling.
EC521.4	To build a processing pipeline for Data Science analysis.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC521.1			
EC521.2			
EC521.3			
EC521.4			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC521.1							
EC521.2							
EC521.3							
EC521.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

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Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	**Title**	**Introduction to Data Science**	1.2	**6**
	1.1	The Data Science process, CRISP-DM Framework, Defining goal, retrieving data, pre-processing data, exploratory data analysis, model building and data visualization, Ethical issues in data science, Difference between AI and Data Science		
	1.2	Data Science project Pipeline		
2	**Title**	Mathematical Preliminaries for Data Science	1.2	**6**
	2.1	Statistical Analysis: Mean, Median, Mode, Regression coefficient ,IQR, SD, Variance, Co variance, Correlation coefficient, kurtosis		
	2.2	Probability and Probability Distribution: Normal Distribution, Binomial Distribution, Poisson Distribution ,Analysis of Covariance, Data Mining (Association Mining, Apriori with Real data), Cumulative Probability, Continuous probability Distributions, Central Limit Theorem, Baye's Theorem, Naïve Bayes Theorem, Null and alternative Hypotheses, Linear Discriminant Analysis(LDA), QDA.		
3	**Title**	Predictive modeling and Descriptive Modeling	1.2	**6**
	3.1	Predictive Modeling: Simple Linear Regression, Predictive modeling process, supervised and unsupervised learning, parametric and nonparametric models, business intelligence, challenges in using predictive analytics, Introduction to time series analysis and time series mining, Introduction to spatio-temporal data, spatio-temporal model, fast dynamic time warping.		
	3.2	Descriptive Modeling: Linear Algebra and Matrix computation, Principal components analysis (PCA), singular value decomposition (SVD), probabilistic PCA, applying, PCA to new data, PCA for data interpretation., EM algorithm for PCA, Independent Component Analysis (ICA).		
4	**Title**	Evaluation Methodology for data science	1.2	**6**
	4.1	Experimental setups, training, tuning, test data, holdout method, cross-validation, bootstrap method. Measuring performance of a model: Accuracy, ROC curves, precision-recall curves, loss functions for regression Interpretation of results: Confidence interval for accuracy, hypothesis tests for comparing models, algorithms.		
5*	**Title**	Self Study		**4**
	1 **2**	Text Analytics and Sentiment Analysis Identify where interesting data sets relevant to the following domains and build a suitable data science pipeline show the outcome E.g (a) Books.(b) Horse racing.(c) Stock prices. (d) Risks of diseases.(e) Colleges and universities .(f) Crime rates.(g) Bird watching.		
			Total	**28**

- **Total 28 hrs does not include this module hours**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Setting up python data science Ecosystem and perform comparative study (E.g Anaconda, Google Colab, Kaggle, Jupyter Notebooks, Tensor flow, keras, Theano and MS NLTK, Pytorch, MS Azure)
2	Using Python, explore different types of datasets (CSV and JSON, excel, txt, pdf, xml, multimedia format, medical format).
3	Data preparation process
4	Feature engineering
5	Clustering techniques and its Application
6	Regression techniques and their Application
7	Classification techniques and their Application
8	Case Study is specific domain
9	Mini Project (Phase 1)
10	Mini Project (Phase 2)

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Doing Data Science	1st	Cathy O'Neil, Rachel Schutt	O'Reilly	2013
2	Python Data Science Handbook: Essential Tools for Working with Data	1st	Jake VanderPlas	O'Reilly	2016

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	The Data science design Module	ISSN 1868-0941 ISSN 1868-095X (electronic) ISBN 978-3-319-55443-3 ISBN 978-3-319-55444-0 (eBook) DOI 10.1007/978-3-319-55444-0	Steven S,Skiena	Springer	2017

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Cyber security Technologies	2	0	2	3	7	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
PE31		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	Computer network, linux operating system ,windows operating system
Course Objective: To prepare students for cyber security and digital forensics job profiles in Cyber security Industry, Academia and Research.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC531.1	Interpret and classify different cybercrimes.
EC531.2	Analyze and implement cyber security techniques and use best security practices.
EC531.3	Analyze the risk involved in the critical infrastructures.
EC531.4	Apply machine learning techniques in cyber security.
EC531.5	Develop a deeper understanding of existing and future network security problems from a decision and game theoretic perspective

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC531.1			
EC531.2			
EC531.3			
EC531.4			
EC531.5			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3
EC531.1			
EC531.2			
EC531.3			
EC531.4			
EC531.5			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to cyber security** - Tenets of Cybersecurity-CIA, Cybercrime, classification of cybercrimes, cyber criminals, various cybercrimes - Phishing, DoS/DDoS, Malware, Ransomware,Virus, Website defacement, scanning & sniffing , SQL injection, Buffer overflow, Session Hijacking ,evil twin, wardriving, bluesnarfing, bluebugging,insecure cloud API,Data Breaches in cloud,Abuse of Cloud Services,cyber terrisisum ,etc. Tools and methods used in cybercrimes, Anatomy of hack ,ethical hack and hacking phase. **Practical Exercises -** • Network reconnaissance with the help of open source tools. • Network scanning with NMAP and Fping. • Network sniffing using TCPdump , Wireshark and TShark. • Web Server scanning using Nikto. • SQL injection,XSS attack. • DoS/Dos attack using Python Scapy • Wireless sniffing using Kismet	1,2,8	6
2		**Cyber security technologies**- Introduction to critical infrastructure and protection. Cryptosystems, PKI and steganography. Identity and Access Management (IAM), Biometric security, multi factor authentication. Intrusion detection and prevention -IDS, IPS, firewall, SIEM, procurement of cyber SOC, IPsec VPN and SSL VPN, Honeypots, User and Entity Behaviour Analytics (UEBA), SOAR. Centralized log management system. **Practical Exercises -** • iptables configuration to demonstrate firewall. • Configuration of IDS system - NIDS using snort, HIDS using ossec and logwatch. • Building SIEM using Prelude-SIEM, Prelude-correlator, Prewikka. • Centralized log management using Syslog-ng and Rsyslog • Implementation of IPsec and VPN using open source. • Implementing Honeypot • Wireless IDS Kismet and NetStumbler • Advanced persistent threat (APT) analysis using ELK stack. • Configuring cloud VAPT. • Implementing PKI using Openssl and pycrypto.	1,2,4 ,5	6

3		**Risk assessment and management** Defining security risk, security risk= vulnerability x assets x threats.Vulnerability assessment (VA), penetration testing (PT),network VAPT, web VAPT, cloud VAPT, IT infrastructure and inventory management ,threats analysis ,risk residue , risk appetite ,computation of risk matrix, use cases. **Practical Exercises -** • Vulnerability assessment using nessus,OpenVas,nikto and nmap. • Penetration testing using metasploit framework. • Demonstration of SE Toolkit • Demonstration of cloud VAPT	1,2,4 ,5,9	6
4		**Cyber security and Machine learning-** Anomaly detection using machine learning techniques, use of data science to catch email fraud and spam detection, Botnet detection, .segregating legitimate and lousy URLs. Malware detection, biometric recognition and software vulnerabilities. Knocking down the CAPTCHAs using artificial intelligence.Machine learning to detect financial fraud. **Practical Exercises -** • Anomaly detection using machine learning technique using KDD cup 1999 dataset, NSL -KDD, UNB datasets • Credit Card Fraud Detection using Pycaret Library • Botnet detection using Machine learning techniques • Knocking down the CAPTCHAs using A.I. • Detection of Phishing attack • Security visualization using open source tools.	6,7	6
5		**Self-Study:** **Game Theoretic approach to cybersecurity**-Classification of games, Game Theory Methods for Cyber Security Applications, Deterministic Security Games-Security Game Model, Intrusion Detection Games, Sensitivity Analysis, Security Games for Vehicular Networks, Security Games in Wireless Networks. Stochastic Security Games-Markov Security Games, Stochastic Intrusion Detection Game. **Practical Exercises -** • Implementing honeypot with the help of game theory.	3	4*
			Total (*Not Included)	**28**

Sr. No	Title of the Laboratory Exercises
1	Network reconnaissance with the help of open source tools.
2	Information Security Coding using Python and Scapy
3	Vulnerabilty Assessment and Penetration Testing (VAPT)
4	Firewall and IDS/IPS
5	Cryptography and PKI
6	Anomaly detection using machine learning techniques
7	Building SIEM
8	APT Detection with ELK
9	Security visualization using open source tools
10	Implementing honeypot with the help of game theory.

References:

Text Books:

Sr. No	Title	Authors	Publisher	Year
1	Information Security: Principles and Practice Hardcover.	Mark Stamp	Wiley-Blackwell	2011
2	Securing the Cloud: Cloud Computer Security Techniques and Tactics.	J. R. Winkler	Syngress	2011
3	Hands-On Machine Learning for Cyber security: Safeguard your system by making your machines intelligent using the Python ecosystem	Soma Halder and Sinan Ozdemir	Packt Publishing	2018
4	Security Operations Center: Building, Operating, and Maintaining your SOC	Joseph Muniz, Gary McIntyre, Nadhem AlFardan	Cisco Press	2015
5	Wireless and Mobile Network Security	Hakima Chaouchi and Maryline Laurent–Maknavicius	ISTE Ltd.	2009
6	Network Security: A Decision and Game-Theoretic Approach	Tansu Alpcan and Tamer Basar	Cambridge University Press	2010

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	Digital Image and Video Processing Lab	0	0	4	3	7	0	0	2	2
EC505		Examination Scheme								
		Component			ISE		MSE		ESE	Total
		Theory			-		--		-	--
		Laboratory			100		--		100	200

Pre-requisite Course Codes, if any.	Signal processing, Discrete Time Signal Processing
Course Objective: To treat the 2D systems as an extension of 1D systems design and discuss mathematical transform techniques specific to 2D systems.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC505.1	Identify the difference between processing and analysis of image and video
EC505.2	Analyze the image in time and frequency domain
EC505.3	Demonstrate different techniques for image enhancement for image and video
EC505.4	Validate segmentation techniques on Image
EC505.5	Differentiate techniques for Image/video compression
EC505.6	Apply motion estimation techniques for video

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

EXP. No.	Topics	Ref.	Marks
	Fundamentals of Image	1,3	5
1.	Image Manipulation Conversion negation, power Law correction		
	Analysis of image in frequency and time domains		
	2-D Transform	1,2,3	5
2.	To Analyze the image, transform in time and frequency domain (DCT, DFT, KL)		
	To Analyze the image, transform in wavelet domain		
	Image Enhancement	2,3	5
3.	Noise identification and filtering techniques to remove it. (Degradation and restoration Model)		
4.	Image enhancement techniques in frequency and time domain		
	Segmentation techniques	3,4	5
5.	Segmentation using edge detection and Thresholding		
6.	Morphological transformation		
	Compression Techniques	5	5
7.	To study and identify Image and video compression standard		
8.	To study qualitative performance data compression by applying compression in different formats on image and video.		
	Motion Estimation	6	5
9.	To Apply Object detection techniques in video traffic		
10.	To Apply and analyze the motion estimation techniques on video		

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Handbook of Image and Video Processing (Communications, Networking and Multimedia)	second edition	Alan C. Bovik	Elsevier, Academic Press	--
2.	Practical Image and Video Processing using MATLAB	--	Marques, John	Wiley & Sons Inc.	--
3.	Digital Image Processing using MATLAB	second edition	Gonzalez and Woods	Tata McGraw Hill	--
4.	Image Processing: An Algorithmic Approach	--	M.A.Joshi	PHI	2006
5.	Image and Video Compression: Fundamentals Techniques and Applications	--	M.A.Joshi, M.Raval, Y.H.Dandawate ,K.R.Joshi, S.P.Metkar	CRC Press	2014
6.	Motion Estimation Techniques for Digital Video Coding:	--	S P Metkar,	--	--

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SEM - II

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Advanced Radiating Systems	3	0	0	5	8	3	0	0	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC506		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	Electromagnetic waves, Fundamentals of Antenna
Course Objective: To design an antenna based on various technical parameters	
Course Outcomes (CO):*At the End of the course students will be able to*	
EC506.1	Apply concepts of EM wave theory for analyzing antenna parameter.
EC506.2	Do a performance analysis and determine gap in existing designs of an antenna based on fundamental theory.
EC506.3	Infer behavior of antenna using parametric analysis and suggest appropriate improvement/revision
EC506.4	Infer behavior of antenna array using parametric analysis suggest appropriate improvement/revision
EC506.5	Judge the usage, validate designs and select antenna according to the requirement
EC506.6	Develop and design antenna based on technical criteria.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC506.1	1	1	3
EC506.2	3	2	3
EC506.3	3	2	2
EC506.4	3	1	2
EC506.5	1	1	3
EC506.6	3	3	3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2
EC506.1	1	1
EC506.2	1	1
EC506.3	1	1
EC506.4	1	1
EC506.5	1	1
EC506.6	1	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamentals of Antenna**	1	08
	1.1	**Antenna Parameters:** Reflection Coefficient, VSWR, Radiation pattern, Gain, Directivity, HPBW, FNBW, Input Impedance, Antenna Efficiency, Effective Aperture, Friis Transmission Equation.		
	1.2	**Types of Antenna**: Dipole and Monopole, Loop and Slot Antennas, Helical Antennas & Horn antennas.		
2		**Linear and Planar Arrays**	1	08
	2.1	**N element linear arrays**: uniform amplitude and spacing- - Directivity of Broadside and End fire arrays.		
	2.2	**Three dimensional characteristics**: Pattern multiplication, Binomial arrays. Mutual coupling in arrays, multidimensional arrays- phased arrays and array feeding techniques.		
3		**Microstrip Antennas**	2	10
	3.1	**Introduction:** Rectangular Patch, Circular Patch, Parametric study, Circularly polarized antennas, Axial Ratio, MSA suspended configuration		
	3.2	MSA Arrays and Feed Networks, Corporate and Series Feeds		
4		**Broadband microstrip antennas**	2	07
	4.1	Introduction, Mechanism of Parasitic Coupling for Broad BW, Gap-Coupled RMSAs, Radiating-Edge Gap-Coupled RMSAs, Nonradiating-Edge Gap-Coupled RMSAs, Gap and Hybrid-Coupled MSA.		
	4.2	Multilayer Broadband MSA, Electromagnetically Coupled MSAs, stack multi resonator MSA, Design Examples.		
5		**Compact Microstrip Antennas**	2	05
		Introduction, Compact Shorted RMSAs, Partially Shorted RMSAs, Effect of Dimensions of RMSAs with a Single Shorting Post, Effect of the Position of the Single Shorting Post, Compact Shorted CMSA and Its Variations.		
6		**Advanced Antennas**		04
	6.1	Leaky Wave Antennas: General principle and recent trends	3	
	6.2	Antennas using Metamaterials: General principle and recent trends	4	
			Total	**42**

Text Books

Sr. No	Title	Authors	Publisher	Year
1	Antenna Theory	C. A. Balanis	Wiley and sons	2005
2	Broadband Microstrip antennas	Girish Kumar and K.P. Ray	Artech House	2003

Reference Books

Sr. No	Title	Authors	Publisher	Year
1	Handbook of Microstrip Antennas	R. James and P.S. Hall	Peter Peregrinus	1989
2	Antenna Theory and Design	W.L. Stutzman and G.A. Thiele	John Wiley	2012
3	Antenna Engineering Handbook	R.C. Johnson	McGraw Hill	1993

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Modern Wireless Communication	3	0	0	5	8	3	0	0	3
EC507		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	--		--		--		--	

Pre-requisite Course Codes, if any.	Mobile Communication, Wireless Networks
Course Objective: To understand and compare Modern wireless Communication systems with classic communication systems.	
Course Outcomes (CO):*At the End of the course students will be able to*	
EC507.1	Identify the Evolution of different Wireless Communication Systems and Standards.
EC507.2	Analyze the Architectural and Operational Differences between 4G and earlier technology.
EC507.3	Illustrate the Mobility management and Inter System operation in LTE.
EC507.4	Compare the Protocol Stack Architecture of 5G with earlier generation technologies

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO-PO	PO1	PO2	PO3
EC507.1	2	1	1
EC507.2	2	1	1
EC507.3	2	1	1
EC507.4	2	1	1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO-PO	PEO1	PEO2
EC507.1	1	1
EC507.2	1	1
EC507.3	1	1
EC507.4	1	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to 2G/3G/4G Wireless Communications**		8
	1.1	Wireless Fundamentals: Cellular concept, Broadband wireless channel (BWC), Fading in BWC, Modeling BWC – Empirical and Statistical models, Mitigation of Narrow band and Broadband Fading	1,2	
	1.2	UMTS Network Reference Architecture: Channel Structure in UMTS Terrestrial Radio Access Network	1,2	
	1.3	Spreading and Scrambling in UMTS, UMTS Terrestrial Radio Access Network Overview, UTRAN Logical Interfaces, Distribution of UTRAN Functions, UMTS Core Network Architecture, Limitations of WCDMA/UMTS	2	
2		**Long Term Evaluation (LTE)**	2,3	8
	2.1	Introduction and system overview: Introduction of OFDM, Single carrier FDMA, Single carrier FDE, Channel Dependent Multiuser Resource Scheduling, Multi-antenna Techniques, IP based Flat network Architecture, LTE Network Architecture.		
	2.2	Overview and Channel Structure of LTE: Channel Structure of LTE, Downlink OFDMA Radio Resource, Uplink SC-FDMA Radio Resource, Downlink Transport Channel Processing, Uplink Channel Transport Processing, Physical Layer Procedures		
3		**Architecture of the LTE Air Interface**	2,3	10
	3.1	Air Interface Protocol Stack, The Resource Grid, Resource Element Mapping, Multiple Antenna Transmission, Cell Acquisition.		
	3.2	Data Transmission and Reception, Data Transmission Procedures, Transmission of Scheduling Messages on the PDCCH, Transmission of Hybrid ARQ Indicators, Uplink Control Information, Uplink Power Control.		
4.		**Mobility Management and Inter System Operation**	2,3	8
	4.1	Transitions Between Mobility Management States, Cell Reselection in RRC_IDLE, Measurements in RRC_CONNECTED, Handover in RRC_CONNECTED		
	4.2	Inter-Operation with UMTS and GSM, Inter-Operation with Generic Non 3GPP Technologies, Inter-Operation with cdma2000 HRPD.		
5.		**Fundamentals of 5G**	4,5	8
	5.1	Understand 5G and NGMN, 5G RAN and dynamic CRAN, Architecture deployment,5G Protocol stack-Control Plane and User Plane, MAC Layer, RLC, PDCP Layer architecture, Advantages and challenges, Applications.		
	5.2	Mobile edge computing and FOG computing, Distributed MIMO Spectrum requirement, Millimeter wave propagation,		
6.	**Self Study Topics**	**Self Study Topics:** LTE Integration with existing 2G/3G Networks, LTE Security, LTE Mobility, QOS in LTE, 5G Interfaces. (One Hour Each)	3,4	5*
		Total (* Not Included)		42

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	"Fundamental of Wireless Communication"	Second	Davis Tse and Pramod Viswanath	Cambrige University Press	2005
2	4G, LTE-Advanced Pro and The Road to 5G	Third	Erik Dahlman Stefan Parkvall Johan Sköld	Elsevier Publication	2010
3	An Introduction to LTE, LTE-advanced, SAE And 4G Mobile Communications.	Second	Christopher Cox	Wiley Publication	2012

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Mobile Network Engineering GSM, 3G-WCDMA, LTE and the Road to 5G	First	Alexander Kukushkin	Wiley Publication	
2	Principles of Modern Wireless Communication Systems: Theory and Practice	Second	Aditya K. Jagannatham	McGraw-Hill Education	

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Software defined radio and its applications	2	0	2	3	7	2	0	1	3
EC512		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Digital signal processing, wireless communication
Course Objective: To teach Software defined radio architecture and its performance parameters.	
Course Outcomes (CO):*At the End of the course students will be able to*	
CO1	Describe various architecture aspects of SDR
CO2	Analyze the behavior, need and challenges associated with various system components
CO3	Justify the usage of various system components
CO4	Evaluate performance parameters of SDR subsystem.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC512.1	2	2	1
EC512.2	2	1	2
EC512.3	2	1	2
EC512.4	2	1	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2
EC512.1	1	1
EC512.2	1	2
EC512.3	1	2
EC512.4	1	2

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to software defined radio**	1	04
		Introduction, networking, RF architecture,		
		Processing architectures and software environment		
2		**Signals and systems for SDR**	1,2	06
	2.1	Receive techniques for SDR, Transmit techniques for SDR		

	2.2	Digital signal processing for SDR		
3		**Understanding SDR hardware**	1,2	08
	3.1	components of an SDR,AD9363 Details, Zynq Details, Linux Industrial Input/Output Details ,MATLAB as an IIO client		
	3.2	Radio I/O Basics, Continuous Transmit Latency and Data Delays, Receive Spectrum, Automatic Gain Control, Common Issues, Example: Loopback with Real Data, Noise Figure		
4		**OFDM for SDR: Merits and Challenges**	2	04
	4.1	Need for OFDM, spectrum sensing, spectrum shaping, MIMO, spectral allocation, Interoperability, challenges and mutual interference, multiband OFDM		
5		**Applications of SDR**	1,2	06
		Cognitive Radio, Bumblebee Behavioral Model, Vehicular Networking		
Self study: Cognitive radio-Functions, Components and Design Rules, Building the CRA on SDR Architectures, SDR and Cognitive Radio Relationship				**06***
			Total	**28**

Sr. No	Title of the Experiment
1	Implementation of OFDM and measurement of performance parameters
2	Study of nonlinear distortion parameters in SDR
3	Performance Analysis of SDR transceiver
4	Spectrum sensing using GNU radio and SDR.
5	Understanding effect of multipath and fading channel in transceiver design
6	Transmit and receive a single tone signal using NI 2920 and Labview
7	Study of Packet transmission and reception using NI 2920 USRP and labview
8	Case study: cooperative sensing
9	Case study: cross layer optimization
10	Case study: Implementation predistortion technique for SDR

Text Books

Sr. No	Title	Authors	Publisher	Year
1	Software-Defined Radio for Engineers	Travis F. Collins Robin Getz Di Pu Alexander M. Wyglinski	Artech	2018
2	Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems	HÜSEYIN ARSLAN	Springer	2007

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Machine Intelligence	2	0	2	5	9	2	0	1	3
		Examination Scheme								
EC522		Component	ISE		MSE		ESE		Total	
		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	
Course Objective: To apply skills of machine learning algorithms on real-life applications	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC522.1	To select appropriate Data Visualization techniques for a given scenario.
EC522.2	Evaluate the performance of Classification/ Clustering algorithms.
EC522.3	Apply Artificial Neural Networks on large dataset.
EC522.4	Implement Forecasting algorithms to solve real-world problems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC522.1			
EC522.2			
EC522.3			
EC522.4			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC522.1							
EC522.2							
EC522.3							
EC522.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Visualization**		2
	1.1	Introduction to data visualization	1	
	1.2	When, Why and Where to use: Bar Graph, Pie chart, Dot plot, Line graph, Scatter plot, Histogram (uniform, non-uniform width), Box Plot, Heat Map		

2		**Supervised Machine Learning**		**6**
	2.1	Introduction to Machine Learning, Types- Supervised, Un supervised, Semi-supervised	2	
	2.2	Basic Concepts, Classification methods: Decision Tree Induction, Attribute Selection Measures, Tree pruning. Bayesian Classification: Naïve Baye's Classifier, Support Vector Machine, Bayesian Belief Networks, Hidden Markov Model		
	2.3	Ensemble Methods: Bagging, Boosting- AdaBoost, , Random Forests		
3		**Unsupervised Machine Learning**		**5**
	3.1	Cluster Analysis: Basic Concepts, Partitioning Methods: K-Means, K-Medoids. Hierarchical Methods: Agglomerative, Divisive, BIRCH	2	
	3.2	Density-Based Methods: DBSCAN, OPTICS		
	3.3	Outlier Detection Methods: Supervised, Semi-Supervised, Unsupervised, Proximity based, Clustering Based		
4		**Artificial Neural Networks**		**8**
	4.1	Fundamental Concepts and Models of Artificial Neural Systems: Biological Neurons and Their Artificial Models, Models of Artificial Neural Networks, Neural Processing, Learning and Adaptation, Neural Network, Learning Rules and Comparison.	3	
	4.2	Linearly and Non-Linearly Separable Pattern Classification.		
	4.3	Perceptron Convergence Theorem		
	4.4	Multi-layer Feed forward Network: Delta Learning Rule for Multi-Perceptron Layer, Generalized Delta Learning Rule, Feed forward, Recall and Error, Back-propagation Training, Learning Factors		
5		**Forecasting**		**7**
	5.1	Basics of Time Series, Defining the forecasting problem , Holt-Winters' seasonal method	4	
	5.2	Correlation analysis, simple linear regression, statistical tests of significance, multiple regression, causal factors in multiple regression, statistical characteristics of this method.		
	5.3	Short-range forecasting, Analysis of Time Series data-plots, seasonality, Auto correlation, ARIMA Models		
6*	**Self Study**	Case Studies: Pinterest – Improved Content Discovery, Twitter – Curated Timelines, HubSpot – Smarter Sales, Google, Salesforce – Intelligent CRMs, LinkedIn Deep Learning: Introduction, Convolutional Neural Network, Recurrent Neural Network, Generative Adversarial Network, Reinforcement learning (Markov Decision Processes, Value Iteration)Q-learning	R1	**5***
			Total	**28**

***Total 28 hrs. does not include this module's hours.**

Laboratory:

Sr. No	Title of the Experiment
1	Data Visualization: Use appropriate data set and demonstrate various charts
2	Supervised Learning: Choose appropriate dataset for internet traffic analysis and apply algorithms like: naïve Bayes, Support Vector Machine. Analyze and compare their performance metrics.
3	Supervised Learning: For credit card fraud detection, choose a dataset and apply Decision tree, Random Forest algorithm. Measure and evaluate model performance.
4	Unsupervised learning: Choose appropriate dataset for document classification and form appropriate clusters using partition based clustering algorithms and evaluate performance metrics.
5	Unsupervised learning: Form appropriate clusters using hierarchical clustering algorithm and density based clustering, analyze and compare their performance metrics.
6	Neural Networks: Apply neural networks for character recognition.
7	Neural Networks: Apply Multilayer Perceptron for a scenario like Autonomous Driving - Image Recognition, Object detection, Route Adjustment, and evaluate model performance.
8	Neural Networks: Apply back propagation algorithm for face recognition and evaluate model performance.
9	Time Series: Perform analysis on Covid-19 dataset with the help of Holt and Winter Model.
10	Time Series: Analyze Share Market with ARIMA Model and forecast potential good stocks.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Storytelling with data	1st	Cole Nussbaumer Knaflic	Wiley	2015
2	Introduction to Machine Learning with Python: A Guide for Data Scientists	1st	Müller, Andreas C., Guido, Sarah	O'Reilly	2016
3	Introduction to Artificial Neural Systems	1st	Jacek M. Zurada	Jaico Publishing House	2000
4	Time series analysis and its applications	5th	Robert H. Shumway	Springer	2000

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Deep Learning	1st	Ian Goodfellow, Yoshua Bengio and Aaron Courville	The MIT Press	2017

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Digital Forensics and Incident Response (DFIR)	2	0	2	3	7	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
PE32		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Cyber Security and Digital Forensics
Course Objective: To prepare students for cyber security and digital forensics job profiles in Cyber security Industry, Academia and Research.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC532.1	To analyze the hardware, software, firmware and tools etc for forensic investigation processes.
EC532.2	Create documents and maintain chain of custody.
EC532.3	Develop Python scripting to perform a variety of forensic collection and analysis tasks.
EC532.4	Develop digital forensics is part of the incident response (IR) capability Incident Response is an integral part of information Assurance (IA) and Forensic readiness. Create Evidence-centric procedures and processes.
EC532.5	Apply appropriate domestic and international law.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC532.1			
EC532.2			
EC532.3			
EC532.4			
EC532.5			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3
EC532.1			
EC532.2			
EC532.3			
EC532.4			
EC532.5			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Digital Forensics:** Cyberspace and criminal behavior, cyber crime investigation, forensics science, forensics methodologies, cyber incident handling and response, Controlling Contamination-the Chain of Custody, Legal perspectives and security compliance of digital forensics. ISO standards relating to Digital Evidence, SWDGE Model SOP for Computer Forensics, NIST Digital Evidence.	1,2	**6**
2		Setting up an electronic evidence forensics laboratory, Phases of Forensics. Grow your own tools for Computer Forensics with help Python Libraries. **Practical Exercises:** To develop Python scripting to perform a variety of forensic collection and analysis tasks. To demonstrate using Python to work with encrypted files, to extract metadata, to examine windows artifacts, to track Web and email usage, to foot print applications, to carve artifacts from volatile memory, to carve file systems, and to analyze network traffic. Implementing Python frameworks for development of further tools.	3,4	**6**
3		**Network Forensics:** Applying Forensic Science to Networks Preparation and Authorization, Identification Documentation, Collection, and Preservation, Filtering and Data Reduction, Class/Individual Characteristics and Evaluation of Source, Evidence Recovery, Investigative Reconstruction, Reporting Results Network Forensics Analysis Toolkit (NFAT) **Practical Exercises:** Collection of network traffic data (Live acquisition and dump) Analyzing the traffic and persevering original. Implementing network sensors. Correlate with host sensors. Develop an algorithm to filter and extract anomalous traffic. Use open source and commercial domain tools for NFA. Event reconstruction. OSINT Tools-tshark, wireshark, tcpdump & xplico **Windows Forensics:** Digital Evidence on Windows Systems, File Systems, Data Recovery, Log Files, Registry, Internet Traces, Program Analysis. Tools and methods. **UNIX/Linux OS Forensics:** UNIX Evidence Acquisition Boot Disk, File Systems, Overview of Digital Evidence Processing Tools, Data Recovery, Log Files, File System Traces Internet Traces Tools and methods. **Practical Exercises:** To perform live analysis, capture volatile data, make images of	3,4, 5,6	**6**

		media, analyze filesystems, analyze network traffic, analyze files, perform memory analysis, and analyze malware for a Windows subject on a Linux system with readily available free and open source tools. Windows Registry analysis. To build an in-house forensic capability via a variety of free, open-source, and commercial tools provided within the SANS Windows SIFT Workstation, NST etc		
4		**Malware Forensics, Memory Forensics and Disk Forensics:** File Identification and Profiling in Windows and Linux Analysis of a Suspect Program, Discovering and Extracting Malware and Associated Artifacts from Linux Systems and Windows systems, Memory Forensics: Analyzing Physical and Process, Memory Dumps for Malware Artifacts, Malware Incident Response: Volatile Data Collection and Examination on a Live Windows Systems and Linux systems. Tools and techniques of conducting runtime behavioral malware analysis and static code analysis. **Practical Exercises:** Collecting data from system memory (system registers, cache, RAM) in raw form and then carving the data from Raw dump. Extracting data from storage media by searching active, modified, or deleted files. OSINT tools, TCT, Autopsy, Sleuth-kit, volatility tools. **Email Forensics:** Broad steps in email forensics, Investigate Email Headers, Sender IP address, Verify Emails, Fake Email Investigation, Hacked, Email Scams. Tools and methods used in Email Forensics. **Practical Exercises:** Identification of malicious code, to study their payload, viruses, worms, etc. Recovery and analysis of emails, including deleted emails, calendars, and contacts	6,7, 8	**6**
5		**Self-Study:** **Anti Forensics** Anti-forensics techniques, detection and countermeasures **Incident Handling and Icident Response** Development of Incident Handling and Response methodology (PDCAERF) Incident Response is an integral part of information Assurance (IA) Forensic readiness. Evidence-centric procedures and processes. Proper evidence handling and management, Determining the scope Containment strategies. Event reconstruction, Review the incident. Follow up reporting. **Practical Exercises:** To develop digital forensics is part of the incident response (IR) capability & Automated report mechanism.	7,8, 9,10	**4***
			Total (*Not Included)	**28**

Sr. No	Title of the Laboratory Exercises
1	Setting up an electronic evidence forensics laboratory
2	Network Forensics using Open Source Tools-NFAT
3	Computer Forensics
4	To develop Python scripting to perform a variety of forensic collection and analysis tasks.
5	Memory Forensics
6	Disk Forensics & Email Forensics
7	Malware Forensics
8	Windows Forensics
9	Linux Forensics
10	To develop digital forensics is part of the incident response (IR) capability & Automated report mechanism.

Text Books:

Sr. No	Title	Authors	Publisher	Year
1	Crime Scene Forensics A Scientific Method Approach	Robert C Shaler	CRC Press	2011
2	Computer Forensics and Cyber Crime: An Introduction	Marjie T. Britz	Pearson	2013
3	Computer Forensics Evidence Collection & Preservation	EC-Council	Cengage Learning	2010
4	Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet	Eoghan Casey BS MA	Academic Press	2011
5	Computer Forensics: Computer Crime Scene Investigation	John R. Vacca	Charles River Media	2002
6	Malware Forensics: Investigating and Analyzing Malicious Code	Cameron H. Malin ,Eoghan Casey, James M. Aquilina	Syngress	2008
7	Introduction to Network Forensics	The European Union Agency for Network and Information Security(ENISA)	ENISA	2019
8	Windows Forensics: The Field Guide for Corporate Computer Investigations	Chad Steel	John Wiley & Sons	2006

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Applied Optimization for Wireless, Machine Learning, Big Data	2	0	2	3	7	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC513		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Basic Course on Calculus, Probability, Matrices
Course Objective: To develop the fundamental tools/ techniques in modern optimization as well as illustrating their applications in diverse fields such as Wireless Communication, Signal Processing, Machine Learning, Big Data and Finance.	
Course Outcomes (CO):*At the End of the course students will be able to*	
EC513.1	Evaluate Vectors and matrices; optimization functions
EC513.2	Analyze and Evaluate optimization in MIMO and Wireless systems
EC513.3	Analyze and Evaluate optimization in Machine Learning
EC513.4	Analyze and Evaluate optimization in Big Data Analytic

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC513.1	2	1	1
EC513.2	2	1	1
EC513.3	2	1	1
EC513.4	2	3	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2
EC513.1	1	1
EC513.2	1	1
EC513.3	1	1
EC513.4		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Basic Calculus and Mathematical Optimization**	1,2	04
		Introduction to properties of Vectors, Norms, Positive Semi-Definite matrices, Gaussian Random Vectors		
		Introduction to Convex Optimization – Convex sets, Hyperplanes/ Half-spaces etc. Application: Power constraints in Wireless Systems		
2		**Optimization Functions and Application in Wireless Systems**	1,2	05
	2.1	Convex/ Concave Functions, Examples, Conditions for Convexity. Application: Beamforming in Wireless Systems, Multi-User Wireless, Cognitive Radio Systems		
	2.2	Convex Optimization problems, Linear Program, Application: Power allocation in Multi-cell cooperative OFDM		
3		**Matrix Optimization for MIMO & Wireless Systems**	1, 3	07
	3.1	QCQP, SOCP Problems, Application: Channel shortening for Wireless Equalization, Robust Beamforming in Wireless Systems		
	3.2	Duality Principle and KKT Framework for Optimization. Application: Water-filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO-OFDM systems		
	3.3	Optimization for signal estimation, LS, WLS, Regularization. Application: Wireless channel estimation, Image Reconstruction-Deblurring		
4		**Applied Optimization for Machine Learning**	1,2	06
	4.1	Application: Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines		
	4.2	Application: Cooperative Communication, Optimal Power Allocation for cooperative Communication, Geometric Program		
5		**Applied Optimization for Wireless & Big Data,**	1,2,3	06
	5.1	Application: Radar for target detection, Array Processing, MUSIC, MIMO-Radar Schemes for Enhanced Target Detection		
	5.2	Application: Convex optimization for Big Data Analytics, Recommender systems, User Rating Prediction, Optimization for Finance		
			Total	**28**

Sr. No	Title of the Experiment
	(To be conducted in R / Python / Scilab / Matlab or any other suitable tool.)
1	Examples on Calculus, Matrices, Probability
2	Examples on Optimization functions
3	QCQP, SOCP Problems
4	Power constraints in Wireless Systems
5	Power allocation in Multi-cell cooperative OFDM

6	Optimization for MIMO Systems, OFDM Systems
7	Optimization for signal estimation, Wireless channel estimation, Image Reconstruction-Deblurring
8	Optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines
9	Optimization for cooperative Communication, Geometric Program
10	Convex optimization for Big Data Analytics

Text Books

Sr. No	**Title**	**Authors**	**Publisher**	**Year**
1	Convex Optimization	Stephen Boyd, Lieven Vandenberghe	Cambridge University Press	2009
2*	Optimization for Machine Learning	SuvritSra, Sebastian Nowozin, Stephen Wright	MIT Press, Cambridge, Massachusetts	2012
3#	Convex Optimization for Signal Processing and Communications: From Fundamentals to Applications	Chong-Yung Chi, Wei-Chiang Li, Chia-Hsiang Lin	CRC Press	2017

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Explainable AI (XAI)	2	0	2	4	8	2	0	1	3
EC523		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC523.1	Apply basic methods and algorithms from area of explainable artificial intelligence.
EC523.2	Demonstrate ideas behind explainable AI and its usage.
EC523.3	Formulate problems as problems from area of artificial intelligence or improve existing code using learned methods.
EC523.4	Evaluate applications and background algorithms used for their implementation through used cases.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC523.1			
EC523.2			
EC523.3			
EC523.4			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC523.1							
EC523.2							
EC523.3							
EC523.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Method for interpreting AI systems**:	1	6
	1.1	Neural Networks via feature visualization, Interpretable Text-Image synthesis, Unsupervised Discrete Representation Learning,		

		Towards Reverse-Engineering Black-Box Neural Networks.		
2	**Title**	**Explaining the Decisions of AI Systems**:	1	**6**
	2.1	Explanations for Attributing Deep Neural Network Predictions, Gradient-Based Attribution Methods, Layer-Wise Relevance Propagation: An Overview, Explaining and Interpreting LSTMs		
3	**Title**	**Evaluating Interpretability and Explanations**:	1	**6**
	3.1	Comparing the Interpretability of Deep Networks via Network Dissection, Gradient-Based Vs. Propagation-Based Explanations: An Axiomatic Comparison, The (Un)reliability of Saliency Methods		
4	**Title**	**Applications of Explainable AI**:	1	**6**
	4.1	Visual Scene Understanding for Autonomous Driving Using Semantic Segmentation, Understanding Patch-Based Learning of Video Data by Explaining Predictions, Interpretable Deep Learning in Drug Discovery, Neural Hydrology – Interpreting LSTMs in Hydrology, Feature Fallacy, Current Advances in Neural Decoding: Complications with Interpreting Linear Decoding Weights in fMRI		
5	**Self Study**			**4***
	5.1	Software and Application Patterns for Explanation Methods, Tensor Flow / Keras / SystemML / PyTorch **Practice Exercise**: explore Tensor Flow / keras / SystemML / PyTorch		
			Total	**28**

***Total 28 hrs does not include this module hrs.**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Develop understanding of reverse engineering in NN
2	Text-to-Image Synthesis using MS-COCO dataset
3	Unsupervised Discrete Representation Learning
4	Perform sequential data modeling and forecasting using LSTM
5	Study of Software and application patterns for explanation methods

Sr. No	Title	Edition	Authors	Publisher	Year
1	Explainable AI: Interpreting, Explaining and Visualizing Deep Learning,	LNAI, volume 11700	Samek, W., Montavon, G., Vedaldi, A., Hansen, L.K., Müller, K.-R. (Eds.)	Springer	2019

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE3	Mobile Device Forensics & Cloud Forensics	2	0	2	3	7	2	0	1	3
		Examination Scheme								
EC533		Component	ISE		MSE		ESE		Total	
		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	Cyber Security and Digital Forensics, Digital Forensics and Incident Response (DFIR)
Course Objective: To prepare students for cyber security and digital forensics job profiles in Cyber security Industry, Academia and Research.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC533.1	Differentiate between computer and mobile device forensics.
EC533.2	Analyze requirements of mobile device forensics and setup mobile device forensics laboratory various tool.
EC533.3	Demonstrate techniques and tools used for mobile device forensics investigations with documents creation and maintain chain of custody.
EC533.4	Select appropriate tools for cloud storage forensics.
EC533.5	Prepare and present report on mobile device and cloud forensics as per security compliance

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC533.1			
EC533.2			
EC533.3			
EC533.4			
EC533.5			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3
EC533.1			
EC533.2			
EC533.3			
EC533.4			
EC533.5			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Mobile Forensics :** Mobile Phone Basics, Inside Mobile device: Cell Phone Crime, SIM Card, SIM Security, Mobile forensic & its challenges,, Mobile phone evidence extraction process, Practical mobile forensic approaches, Mobile operating systems overview, Mobile forensic tool leveling system, Data acquisition methods. **Practical Exercise:** Popular tools for manual extractions include: Project-A-Phone Fernico ZRT and EDEC Eclipse The tools used for logical extraction include: XRY Logical , Oxygen Forensic Suite and Lantern	6,8	**6**
2		**Electronics Evidences:** Electronic evidence stored on mobile phone, Rules of evidence Good forensic practices, Securing the evidence, Preserving the evidence, Documenting the evidence **Practical Exercise:** The common tools used for hex dump include: XACT , Cellebrite UFED Physical Analyzer And Pandora's Box The popular tools and equipment used for chip-off include: iSeasamo Phone Opening Tool , Xytronic 988D Solder Rework Station, FEITA Digital inspection station, Chip Epoxy Glue Remover, Circuit Board Holder	3,4	**6**
3		**The Android device model**: The Linux kernel layer, Libraries, Dalvik virtual machine, The application framework layer, The applications layer. Android security, Android file hierarchy, Android file system, Viewing file systems on an Android device, Extended File System – EXT, Android Forensic Setup and Pre Data Extraction Techniques A forensic environment setup, Screen lock bypassing techniques Gaining root access, Android Data Extraction Techniques, Imaging an Android Phone, Data extraction techniques,, Android Data Recovery Techniques, Data recovery, Android App Analysis. **Practical Exercises:** Overview of Forensic Tools, Android app analysis,Reverse engineering Android apps, Cellebrite – UFED, MOBILedit,, Autopsy, Digital Evidence from Smart band, smart watch, IoT devices	10,11	**6**

4		**Introduction to Cloud Forensics:** Cloud Computing Basics-Cloud Architecture-SAAS,IAAS & PAAS Cloud types-Public, Private, Community and Hybrid.Usage of cloud forensics, Challenges and Issues with Cloud Forensics,The three dimensions of cloud forensics, Cloud forensic organizational structure, Chain of Dependencies,Multi-Jurisdiction and multi-tenancy,Digital forensics evidence acquisition in cloud storage service: examining and evaluating tools and techniques, **Standards and Policies:** GDPR clauses and Cloud contract (IaaS, PaaS,SaaS)	5,7, 12	**6**
5		**Self Study:** **Case Study:** 1. Forensics-as-a-Service 2. Cloud storage forensics: ownCloud as a case study **Practical Exercises:** Tools for Cloud Forensic: FROST, UFED Cloud Analyzer, . diffy, MD-CLOUD, EnCase, FTK, Oxygen Forensic, SIFT	13,14	**04**
			Total	**28**

Sr. No	**Title of the Laboratory Exercises**
1	Setting up Mobile/Handheld Device Forensic Laboratory
2	Mobile/ Smart Phone Forensic Part-I
3	Mobile/ Smart Phone Forensic Part-II
4	Mobile/ Smart Phone Forensic Part-III
5	Handheld/Portable Device Forensics
6	Mobile Malware Analysis
7	Automated Forensic Analysis of Mobile Applications on Android Devices
8	Application Development for Mobile Forensics and Investigation
9	Tools for Cloud Forensic : FROST , UFED Cloud Analyzer, diffy, MD-CLOUD
10	Cloud storage forensics: own Cloud as a case study

References:

Text Books:

Sr. No	Title	Authors	Publisher	Year
1	Crime Scene Forensics A Scientific Method Approach	Robert C Shaler	CRC Press	2011
2	Computer Forensics and Cyber Crime:An Introduction	Marjie T. Britz	Pearson	2013
3	Computer Forensics Evidence Collection & Preservation	EC-Council	Cengage Learning	2010
4	Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet	Eoghan Casey BS MA	Academic Press	2011
5	Computer Forensics: Computer Crime Scene Investigation	John R. Vacca	Charles River Media	2002
6	Malware Forensics: Investigating and Analyzing Malicious Code	Cameron H. Malin ,Eoghan Casey, James M. Aquilina	Syngress	2008
7	Introduction to Network Forensics	The European Union Agency for Network and Information Security(ENISA)	ENISA	2019
8	Practical Mobile Forensics	Satish Bommisetty and Rohit Tamma	Packt Publishing Limited	2014
9	Mobile phone security and forensics: A practical approach	Iosif I. Androulidakis	Springer publications	2012
10	Android Forensics: Investigation, Analysis and Mobile Security for Google Android	Andrew Hogg	Synergy	2011
11	iPhone and iOS Forensics: Investigation, Analysis and Mobile Security for Apple iPhone, iPad and iOS Devices	Andrew Hoog and Katie Strzempka	Synergy	2011
12	Wireless Crime and Forensic Investigation	Gregory Kipper	Auerbach Publications	2007
13	Practical Cloud Security: A Guide for Secure Design and Deployment	Chris Dotson	Shroff/O'Reilly	2019

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	High Performance Computing Lab	0	0	4*	3	7	0	0	2	2
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
EC508		Theory		--		--		--		--
		Laboratory		100		--		100		200

*Including 1 Hour Theory

Pre-requisite Course Codes, if any.	Operating Systems Design and Analysis of Algorithms Computer Networks Programming Language Concepts
Course Objective:-	
Course Outcomes (CO):*At the End of the course students will be able to*	
EC508.1	Analyze a programming task and identify what portions admit a parallel implementation.
EC508.2	Apply the different parallel computing approaches using MPI and Open MP platform for achieving high performance.
EC508.3	Apply the different parallel computing approaches using Open CL platform for achieving high performance.
EC508.4	Develop well-optimized threaded applications using memory management and data transfer methodology on CUDA platform for achieving high performance.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC508.1			
EC508.2			
EC508.3			
EC508.4			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC508.1							
EC508.2							
EC508.3							
EC508.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze✓	Evaluate	Create

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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**HPC Architectures and Algorithm Design**	1,2	3
	1.1	**Standard Parallel Programming Systems**: MPI & Open-MP, Open-CL, CUDA, Heterogeneous Computer Memories and Data Transfer, Host Code, Applications of Heterogeneous Computing, Benchmarking CGM		
	1.2	**Parallel Algorithm Design:** Task/Channel Model, Foster's Design Methodology, Boundary Value Problem, Finding the Maximum, The n-Body Problem		
2	**Title**	**MPI and Open-MP Programming**	2	2
	2.1	**Message-Passing Programming:** Message-Passing Model, Message-Passing Interface, Circuit Satisfiability Problem, Collective Communication		
	2.2	**Shared-Memory Programming:** Shared-Memory Model, Parallel for Loops, Declaring Private Variables, Critical Sections, Reductions		
3	**Title**	**Open-CL Fundamentals and Programming**	1	3
	3.1	**Open-CL Overview:** Using Open-CL, Platforms and Devices, Open-CL Platforms C++, Open-CL Context to Manage Devices, Open-CL Context to Manage Devices using C++, Error Handling		
	3.2	**Work-Item and Work-Groups:** Command Queues, Work-Items and Work-Groups, Open-CL Memory, Programming and Calling Kernel.		
	3.3	**Open-CL Example:** Structure of the Open-CL Host Program, Structure of Open-CL host Programs in C++, The SAXPY Example, Step by Step Conversion of an Ordinary C Program to Open-CL		
4	**Title**	**CUDA GPU Programming - I**	3	3
	4.1	**CUDA Basics** - Timing the Kernel, Timing with CPU Timer and nvpr of, Organizing Parallel Threads, Managing Devices.		
	4.2	**CUDA Execution Model** - Nature of Warp Execution, Exposing Parallelism, Checking Active Warps, Memory Operations, Avoiding Branch Divergence, Unrolling Loops, Dynamic Parallelism		
5	**Title**	**CUDA GPU Programming - II**	3	3
	5.1	**CUDA Global, Shared and Constant Memory Model:** Memory Management, Memory Access Patterns, Matrix Addition with Unified Memory, Data Layout of Shared Memory, Reducing and Coalescing Global Memory Accesses, Constant Memory.		
	5.2	**CUDA Streams and Concurrency:** Streams and Events, Concurrent Kernel Execution, Overlapping Kernel Execution and Data Transfer, Overlapping GPU and CPU Execution.		
6	**Self Study**	1) Parallel Architectures: Interconnection Networks, Processor Arrays, Multiprocessor, Multicomputer, Flynn's Taxonomy. 2) Investigate the various GPU-accelerated CUDA libraries like CUSPARSE, cuBLAS, cuFFT and cuRAND library.	3	4*
			Total (*Not Included)	14

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Laboratory Component (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
	MPI Programming
1	Implement Sieve of Eratosthenes with following data decomposition options: i) interleaved data decomposition and ii) block data decomposition using Parallel MPI programming and then analyze the algorithm.
2	Implement Floyd's version of All-Pair Shortest-Paths Problem through four steps of parallel algorithm design namely partitioning, communication, agglomeration and mapping decomposition using Parallel MPI programming and then analyze the algorithm.
3	Implement Matrix-Vector Multiplication using various Data Decomposition Options: i) Rowwise Block-Striped, ii) Columnwise Block-Striped Decomposition and iii) Checkboard Block Decomposition using Parallel MPI programming and then analyze the algorithm.
4	Implement Matrix Multiplication algorithm through i) Sequential Algorithm, ii) Parallel Algorithm - a) Row-wise Block-Striped Decomposition and b) Cannon's Algorithm using Parallel MPI programming and then analyze the algorithm.
5	Implement Linear Systems solution using i) Back substitution, ii) Gaussian Elimination, iii) Iterative Method and iv) Conjugate Gradient Method using Parallel MPI programming and then analyze the algorithm.
	MPI and Open-MP Programming
6	Implement Linear Systems solution using i) Conjugate Gradient Method and ii) Jacobi Method using Parallel MPI and OpenMP programming and then analyze the algorithm.
	Open-CL Programming
7	A histogram is a statistic that shows the frequency of a certain occurrence within a data set. The histogram of an image provides a frequency distribution of pixel values in the image. Write an Open-CL parallel implementation of the histogram algorithm by breaking the image into tiles, compute the histogram for each tile, and then combine the partial histograms computed for each tile into the final histogram of the image. If the image is a color image, the pixel value can be the luminosity value of each pixel or the individual R, G, and B color channels.
8	Write an Open-CL parallel implementation for Dijkstra's Single-Source Shortest-Path Graph Algorithm.
	CUDA Programming
9	Write a CUDA C program to find Matrix Transpose with i) shared memory, ii) padded shared memory and iii) unrolling for a large number of rows and columns of matrix.
10	Write a CUDA C program to integrate function using Trapezoidal Rule on GPU through Synchronization and concurrent execution.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Using OpenCL_ Programming Massively Parallel Computers	FIRST	Janusz Kowalik and Tadeusz Puzniakowski	IOS Press	2012
2	Parallel programming in C with MPI and Open MP	FIRST	Michael J Quinn	McGraw-Hill	2003
3	Professional CUDA C Programming	FIRST	John Cheng, Max Grossman, Ty McKercher	Wrox	2014

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	OpenCL Programming Guide	FIRST	Aaftab Munshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg	Addison-Wesley	2012
2	OpenCL Parallel Programming Development Cookbook-	FIRST	Raymond Tay	Packt Publishing	2013
3	CUDA by Example : An Introduction to General-Purpose GPU Programming	FIRST	Jason Sanders, Edward Kandrot	Addison-Wesley	2010

Sardar Patel Institute of Technology

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Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SBC	5G Technology Lab	0	0	4	3	7	0	0	2	2
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
EC509		Theory		--		--		--		--
		Laboratory		50		--		50		100

Pre-requisite Course Codes, if any.	3G, 4G Technology, C++, Python
Course Objective: Air Interface is one of the most important elements that differentiate between 2G, 3G, 4G and 5G. While 3G was CDMA based, 4G was OFDMA based; this course reveals the contents of air interface for 5G. While 4G brought in a deluge of infotainment services, 5G aims to provide extremely low delay services, great service in crowd, enhanced mobile broadband (virtual reality being made real), ultra reliable and secure connectivity, ubiquitous QoS, and highly energy efficient networks**.**	
Course Outcomes (CO):*At the End of the course students will be able to*	
EC509.1	Install, configure and implement Various Open source Tools For Wireless Network Simulation.
EC509.2	Analyze and Implement Various Modulation Techniques for 5G Technology.
EC509.3	Estimate and Configure Channel Models for 5G.
EC509.4	Analyze the performance of 5G technology for Data Transmission.
EC509.5	Evaluate the Performance of various Indoor and Outdoor Propagation Models for 5G.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3
EC509.1	2	1	1
EC509.2	2	1	1
EC509.3	2	1	3
EC509.4	2	1	1
EC509.5	2	1	3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2
EC509.1	1	1
EC509.2	1	1
EC509.3	1	1
EC509.4	1	1
EC509.5	1	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Exp No.	Experiment Details	Ref.	Marks
1.	Study Hardware and Software equipments and the specifications for 5G.		5
2.	Software Defined Radio using GNU Radio for 5G. (NI/Ettsus)	3	5
3.	End-to-End simulation of 5G Networks with NS3.	1	5
4.	Channel Modulation for 5G using NS3.	1	5
5.	Effect of Distance on Path-loss for Different Channel Models		5
6.	Impact of MAC Scheduling Algorithms on throughput, in Multi User Equipment scenarios. (NYUSIM)	1	5
7.	Performance analysis for Video Transmission using NS3/GNU Radio.	1,3	5
8.	Outdoor and Indoor Propagation.	1,3	5
9	Case Study-1 (Open Ended)		5
10	Case Study-2 (Open Ended)		5
Total	**Note:** Any eight lab exercises for final evaluation.	5 X 8	40

References:

Sr. No	Title	Authors	Publisher	Year
1	NS3 Online Manual			
2	Sci-Lab Online Resources			
3	GNU Online Resources			

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SBC	Communication Skills	1	0	2	2	5	1	0	1	2
EC509		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	--		--		--		--	
		Laboratory	200		--		--		200	

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC509.1	Demonstrate persuasive skills in interviews
EC509.2	Demonstrate creative and critical thinking in Group Discussions
EC509.3	Understand research, analysis and presentation skills
EC509.4	Apply data transformation skills

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC509.1										2		
EC509.2										2		
EC509.3										2		
EC509.4										2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC509.1							
EC509.2							
EC509.3							
EC509.4							

BLOOM'S Levels Targeted (Pl. appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
		√	√		

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Theory Component

Module No.	Unit No.	Topics	Ref.	L Hrs.	P Hrs
1.	**Title**	**Persuasive Skills in Interviews**		**4**	**8**
	1.1	Persuasion using facial expressions, gestures, body language			
	1.2	Persuasion using voice, verbal style, verbal content			
	1.3	Interview skills			
2	**Title**	**Creative and Critical Thinking**		**3**	**6**
	2.1	Different Perspectives to a situation			
	2.2	Group Discussion Skills			
	2.3	Picture based group discussions			
3	**Title**	**Research, Analysis and Presentation Skills**		**3**	**6**
	3.1	What is research? Types of research			
	3.2	Citation styles – a glimpse			
	3.3	Basic Literature Review and Presentation			
4	**Title**	**Data Transformation**		**2**	**4**
	4.1	Graphics to Paragraphs and vice versa			
	4.2	Oral interpretation of graphics			
5	**Self Study**	Research Paper, News Analysis		**3**	**--**
			Total	**39 hrs**	

List of ISEs

Sr. No	Title of the Experiment	Marks
1	Mock Interview	20
2	Group Discussion	20
3	Presentation	20
4	Quiz – Citation Styles	10
5	Data Transformation	20
6	Oral Interpretation of Graphics	10
	Total	**100**

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Interpersonal Skills at Work	2002	John Hayes	McGraw Hill Education	2002
2	Campus Placement: A Comprehensive Guide	2016	Ankur Malhotra	McGraw Hill Education	2016

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	If I Understood You, Would I Have This Look on My Face? My Adventures in the Art and Science of Relating and Communicating	2017	Alan Alda	Random House	2017
2	Effective Communication Skills for Scientific and Technical Professionals	2000	Harry Chambers	Paperback Basic Books	2000
3	The Art Of Writing Together	2008	William Issac	Crown Business	2008
4	Communication Skills	2011	Meenakshi Raman, Sangeeta Sharma	Oxford, India	2011