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ताळगांव पठार,
गोंय – ४०३ २०६
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(Accredited by NAAC)

GU/Acad –PG/BoS -NEP Engg. /2024/621 Date: 04.11.2024

CIRCULAR

The University has notified Ordinance OA-43 governing the Master of Engineering Degree and Post-Graduate Engineering Certificate from the Academic Year 2024-2025 onwards.

The Syllabus of Semester I of the **Master of Engineering in Electronics Communication and Instrumentation Engineering** Programme approved by the Academic Council in its meeting held on 22nd August 2024 is attached.

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Master of Engineering in Electronics Communication and Instrumentation Engineering** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2024.11.04 17:26:09 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of affiliated Engineering Colleges.

Copy to,
1. The Director, Directorate of Technical Education, Govt. of Goa
2. The Chairperson, BoS in Electronics & Telecommunication Engineering.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar Examinations (Prof.), Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

MASTER OF ENGINEERING IN ELECTRONICS COMMUNICATION AND INSTRUMENTATION ENGINEERING
RC 2024-25

TWO YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**ECE-500**	Linear Algebra and Analysis	2	0	0	2
2	**ECE-501**	Programming for Signal Processing Lab	0	0	2	2
3	**ETC-502**	Communication Networks	3	0	0	3
4	**ETC-503**	Communication Networks Lab	0	0	1	1
5	**ECE-502**	Information Theory and Coding	3	0	0	3
6	**ECE-503**	Information Theory and Coding Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
7	**ECE-531**	Image Processing and Machine Vision	3	1	0	4
OR						
8	**ECE-532**	Next Generation Communication Systems	3	1	0	4
Research Specific Elective (RSE) Courses						
9	**REC-561**	Engineering Research & Publications	3	1	0	4
OR						
10	**REC-562**	Literature Review & Technical Writing for Engineers	3	1	0	4
		Total	**14**	**2**	**4**	**20**

THREE YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**TCr**
Programme Specific Core (PSC) Courses						
1	**ECE-500**	Linear Algebra and Analysis	2	0	0	2
2	**ECE-501**	Programming for Signal Processing Lab	0	0	2	2
Programme Specific Elective (PSE) Courses						
3	**ECE-531**	Image Processing and Machine Vision	3	1	0	4
OR						
4	**ECE-532**	Next Generation Communication Systems	3	1	0	4
Research Specific Elective (RSE) Courses						
5	**REC-561**	Engineering Research & Publication	3	1	0	4
OR						
6	**REC-562**	Literature Review & Technical Writing for Engineers	3	1	0	4
		Total	**8**	**2**	**2**	**12**

Issued on: 04/11/2024

SEMESTER I
Programme Specific Core (PSC) Courses
Name of the Programme : Electronics Communication and Instrumentation Engineering
Course Code : ECE-500
Title of the Course : Linear Algebra and Analysis
Number of Credits : 02 (2L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of basic Mathematics, Linear Algebra	
Course Objectives:	The course aims to provide the student with: 1. Understanding of vector spaces, including concepts such as subspaces, bases, dimension, and linear independence 2. Knowledge to Analyze power series and their convergence properties. 3. Knowledge to Apply analysis concepts to solve problems in the area of signal processing and communication engineering 4. An understanding to evaluate the effectiveness of different matrix factorization methods (e.g., LU, QR) for solving linear systems.	
Content:		**No of hours**
Unit -1	**Basic Algebraic Structures and vector spaces** Definitions and properties of Semi-groups, Groups, Rings, Fields, and Vector Spaces, Homomorphisms. Linear Spaces: Linear Independence, Bases, and Dimension–Subspaces, Direct Sums – Linear Transformations, Linear Functionals, Bilinear Functionals, and Projections. **Finite-Dimensional Vector Spaces** Coordinate representation of vectors, change of basis and change of coordinates – Linear operators, Null space and Range space – Rank-Nullity theorem, Operator inverses, Application to matrix theory, range space and null space of a matrix - Matrix of an operator, Operator algebra, change of basis and similar matrices.	**8**
Unit -2	**Inner Product Spaces** Definition of inner product, norms, angle between vectors – Orthogonal sets, Fourier coefficients and Parseval's identity, Gram-Schmidt process, QR factorization – Approximation and orthogonal projection, Computations using orthogonal and non-orthogonal sets, Normal equations – Projection operator, Orthogonal complements, Decomposition of vector spaces, Gram matrix and orthogonal change of basis, Rank of Gram matrix	**6**
Unit -3	**Diagonalizable linear operators** Eigenvalues and eigenvectors, Spectrum and eigenspace of an operator, Properties of the characteristic polynomial, Geometric and algebraic multiplicities – Linear operators with an eigenbasis, Diagonalizability and Similarity Transformation – Cayley-Hamilton Theorem, Nilpotent Transformations. **Quadratic Forms and Factorizations**	**8**

	Definition and Properties of quadratic forms – Hermitian forms, Orthogonal Diagonalization and the Principal axis theorem, Direct-sum decompositions, invariant direct sums – Singular value Decompositions.	
Unit- 4	**Mathematical Analysis and Normed Linear Spaces** Sets, sets of real numbers, countable and uncountable sets, Metric and metric spaces, Neighborhoods, open and closed sets, Dense and nowhere dense sets, compact, perfect and connected sets – Measure and sets of measure zero – Sequences and Series, Continuity and convergence – Norms, Completeness, Continuous linear transformations, Inverses and Continuous inverses, Complete Normed Linear Spaces – Norm induced by the Inner product, Hilbert spaces.	**8**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning , Constructive learning and Collaborative learning	
References/ Readings:	1. G. Strang, Introduction to Linear Algebra, 4th Edn., Wellesley-Cambridge Press, MA, 2009. ISBN-13: 978-0980232776 2. K. Hoffman, R. Kunze, Linear Algebra, 2nd Edn., PHI Learning, Delhi, 2014. ISBN-13: 978-0135367971 3. S. Axler, Linear Algebra Done Right, 3rd Edn., Springer International Publishing, 2015. ISBN-13: 978-3319110790	
Course Outcomes:	The student shall have the ability to CO 1. Explain the concept of algebraic spaces, convergence of sequences and series, and the significance of differentiability and integrability in analysis. CO 2. Demonstrate the principles of vector spaces and linear mappings in practical contexts. CO 3. Apply mathematical concepts and techniques from linear algebra and analysis to solve problems. CO 4. Evaluate the effectiveness of various matrix factorization methods for solving linear systems in different contexts.	

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Name of the Programme : **Electronics Communication and Instrumentation Engineering**
Course Code : **ECE-501**
Title of the Course : **Programming for Signal Processing Lab**
Number of Credits : **2 (2P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of: 1. Basic programming skills in Python/MATLAB 2. Basics of Signals and systems including Sampling, Reconstruction, Convolution. 3. Basics of Signal Processing including Fourier Transform, Multiplexing.	
Course Objectives:	The course aims to provide the student with: 1. Understanding key concepts of sampling and quantization in digital signal processing. 2. Understanding various transforms including DFT, DCT, Wavelets and their role in spectral analysis of signals. 3. Familiarization with design of filter banks and two-channel transmultiplexers in communication systems. 4. Knowledge to develop and implement algorithms for detecting and classifying power quality disturbances using signal processing techniques.	
Content:		**No of hours**
	Simulation (Python/Matlab Implementation) Experiments (Any Ten to be Performed) 1. Sampling, Quantization, Interpolation and Reconstruction 2. Convolution and Correlation 3. Discrete Fourier Transform 4. Discrete Cosine Transform 5. Discrete Wavelet Transform 6. Z-Transform 7. FIR Filter Design 8. Upsampling and Downsampling 9. Polyphase decomposition 10. Two-channel filter bank 11. Two channel Transmultiplexer 12. Transmultiplexer for speech signal 13. Speech Recognition Using Mel-Frequency Cepstral Coefficient 14. QRS Detection in ECG Signal Using Pan-Tomkins Algorithm 15. Power Quality Disturbance Detection	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. S. Esakkirajan, et. al., Digital Signal Processing- Illustration using Python, Springer 2024 Edition, ISBN 978-981-99-6751-3. 2. Vinay K. Ingle and John G. Proakis, Digital Signal Processing using MATLAB, 3rd Editiion, Cengage Learning, ISBN: 978113317305 3. Maurice Charbit, Digital Signal Processing with Python Programming,	

	Wiley-ISTE, 2017, ISBN 978-1-78630-126-0
Course Outcomes:	The student shall have the ability to CO 1. Describe the significance of convolution and correlation in signal processing. CO 2. Apply the various transforms to signals for spectral analysis. CO 3. Evaluate the performance of FIR filters in filtering and signal enhancement applications. CO 4. Implement different signal processing subsystem designs using mathematical programming tools

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Name of the Programme : Electronics Communication and Instrumentation Engineering
Course Code : ETC-502
Title of the Course : Communication Networks
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of Networking Protocols	
Course Objectives:	The course aims to provide the student with: 1. An Introduction to the OSI reference model, Ethernet cabling, and the three-layer hierarchical model. 2. An Understanding of networking devices and IP addressing schemes, including subnetting and VLSM. 3. Capacity to configure routers and implement IP routing protocols, including IPv6. 4. Knowledge of Layer 2 switching, VLANs, and associated protocols.	
Content:		**No of hours**
Unit -1	OSI reference model, Ethernet Cabling, Three Layer Hierarchical Model: Core layer, Distribution layer, Access layer. Networking devices: Hubs, Switches, Routers, Repeaters, and Bridges, 4 layers protocols. IP addressing: class A, B, C, D, E, Private/Public IP Addresses, IPV4 Address types: Unicast, broadcast, multicast.	**13**
Unit -2	IP Subnetting: Subnet masks, Classless Inter-Domain Routing (CIDR), Subnetting Class C Addresses, Subnetting Class B Addresses, and Subnetting Class A Addresses. Variable Length Subnet Masks (VLSM): VLSM Design, Implementing VLSM Networks. IPv6: Benefits and Uses, IPv6 Address types, IPv6 Routing Protocols: Static, RIPv6, EIGRPv6, OSPFv6.	**12**
Unit -3	Router Fundamentals: Hostnames, Banners, Setting passwords. IP Routing: Routing Basics; IP Routing Process; Configuring IP Routing: Static Routing: Static, Default Routing; Dynamic Routing: Routing Protocols Basics, Distance-Vector Routing Protocols, Routing Information Protocol (RIP), Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF); Introduction to Access Control Lists (ACLs): Standard, Extended; Network Address Translation (NAT), HSRP, DHCP, Ether Channels.	**10**
Unit- 4	Layer 2 Switching: Switching services, Types of switches, Spanning Tree Protocols (STP), Configuring Catalyst Switches: Basic Commands, Port security, Virtual LANs (VLANs): VLAN Basics, Routing between VLANs, VLAN Trunking Protocol (VTP): Modes of operation, Configuring VTP.	**10**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/	1. Todd Lammle, CCNA Routing and Switching Study Guide, Wiley-India,	

Readings:	Seventh Edition, 2011. ISBN-13: 978-1119288282 2. Wendell Odom, Cisco CCNA Routing and Switching ICND2 200-101, Official Cert Guide, Cisco Press, 2013. ISBN-13: 978-9332520950 3. CCNA Routing and Switching Portable Command Guide by Scott Empson, Cisco Press, 2016. ISBN-13: 978-1587205880 4. Computer Networking: A Top-Down Approach by James F. Kurose and Keith W. Ross, Pearson Education, 2013. ISBN-13: 978-0133594140
Course Outcomes:	The student shall have the ability to CO 1. Explain the OSI reference model, Ethernet cabling standards, and the three-layer hierarchical model. CO 2. Describe the functions of various networking devices and apply IP addressing schemes, including subnetting and VLSM. CO 3. Configure routers with basic and advanced settings, and implement both static and dynamic routing protocols, including IPv6. CO 4. Design Layer 2 switching services, VLANs, and VTP in network environments.

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Name of the Programme : Electronics Communication and Instrumentation Engineering
Course Code : ETC-503
Title of the Course : Communication Networks Lab
Number of Credits : 1 (1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of Basic programming skills in C/Python	
Course Objectives:	The course aims to provide the student with: 1. Knowledge of Networking software like Cisco Packet Tracer. 2. An Understanding of networking devices and IP addressing schemes, including subnetting and VLSM. 3. Knowledge to configure routers and implement IP routing protocols, including IPv6. 4. An Understanding of Layer 2 switching, VLANs, and associated protocols.	
Content:		**No of hours**
Pedagogy:	List of experiments (Any Ten to be Performed): 1. To build and configure a network using Static Routing using Packet Tracer software. 2. To build and configure a network using Default routing using Cisco Packet Tracer software. 3. To build and configure a network using rip routing using Cisco Packet Tracer Software. 4. To build and configure a network using EIGRP routing using Cisco Packet Tracer Software. 5. To build and configure a network using OSPF routing protocol using Cisco Packet Tracer software. 6. To use VLSM and manage Extended Access Control List using Cisco Packet Tracer software. 7. To study different types of NAT techniques using Cisco Packet Tracer Software. 8. To build and configure a network using static IPv6 routing using Cisco Packet Tracer Software. 9. To build and configure a network using IPv6 RIP routing using Cisco Packet Tracer Software. 10. To build and configure a network using IPv6 EIGRP routing using Cisco Packet Tracer Software. 11. To build and configure a network using ipv6 ospf routing using Cisco Packet Tracer Software. 12. To create, transfer ports, range of ports and to delete a VLAN using Cisco Packet Tracer. 13. To enable trunking on inter-switch connection and verify the configuration using Cisco Packet Tracer. 14. To build and configure a network using different types of Trunk-based inter-VLAN routing using Cisco Packet Tracer software.	**30**

References/ Readings:	1. Todd Lammle, CCNA Routing and Switching Study Guide, Wiley-India, Seventh Edition, 2011. ISBN-13: 978-1119288282 2. Wendell Odom, Cisco CCNA Routing and Switching ICND2 200-101, Official Cert Guide, Cisco Press, 2013. ISBN-13: 978-9332520950 3. CCNA Routing and Switching Portable Command Guide by Scott Empson, Cisco Press, 2016. ISBN-13: 978-1587205880 4. Computer Networking: A Top-Down Approach by James F. Kurose and Keith W. Ross, Pearson Education, 2013. ISBN-13: 978-0133594140
Course Outcomes:	The student shall have the ability to CO 1. Demonstrate the working of Networking software like Cisco Packet Tracer. CO 2. Configure various networking devices and apply IP addressing schemes, including subnetting and VLSM. CO 3. Configure routers with basic and advanced settings, and implement both static and dynamic routing protocols, including IPv6. CO 4. Configure Layer 2 switching services, VLANs, and VTP in network environments.

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Name of the Programme : Electronics Communication and Instrumentation Engineering
Course Code : ECE-502
Title of the Course : Information Theory and Coding
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of: 1. Basic probability theory including the concept of marginal, conditional and joint probabilities. 2. Basic Linear Algebra including concept of matrix operations.	
Course Objectives:	The course aims to provide the student with: 1. An understanding of the concepts related to information theory and coding techniques in communication systems. 2. Knowledge of information theory and coding techniques in data transmission applications. 3. An understanding of the performance of channel capacity and coding techniques. 4. Knowledge of the channel capacity and the performance of different coding schemes in communication theory.	
Content:		**No of hours**
Unit -1	Information Theory: Information content, unit of information, Entropy, Entropy of binary source, rate of information, Joint entropy and conditional entropy. Mutual Information and channel capacity: Noise free channel, Channel with independent input and output, Symmetric channel, Binary symmetric channel (BSC), Binary erasure channel (BEC).	**13**
Unit -2	Cascaded channels, Repetition of signals. Extension of the Zero Memory Sources, Extension of Binary Channels. Sources with finite memory: Markov sources. Shannon's Theorem: Capacity of Gaussian channel: Shannon-Hartley Theorem, Bandwidth–S/N Tradeoff, Shannon Limit. Source Coding: Coding efficiency, Shannon's first fundamental theorem, Lossless coding algorithm, Kraft's inequality, Variable length source coding: Shannon –Fano coding, Huffman coding, (D-ary compact codes)	**12**
Unit -3	Error Control Coding: Linear Block Codes, Syndrome and error detection, standard array and syndrome decoding for error correction, Probability of undetected error for linear block codes.	**10**
Unit- 4	Cyclic Codes: Algebraic Structure of cyclic codes, Binary cyclic code properties, Encoding in systematic form, Circuit for dividing polynomials, Systematic encoding with an (n-k) stage shift register, error detection with an (n-k) stage shift register. Burst Error Correction: Block Interleaving, Convolutional Interleaving.	**10**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive	

	learning and Collaborative learning
References/ Readings:	1. Herbert Taub, Donald Schilling, and Goutam Saha, Principles of Communication Systems, Third Edition, Tata McGraw Hill, 2017, ISBN-13 978-1259029851 : R.P.Singh and S.D.Sapre, Communication Systems: Analog and Digital , Third Edition, Tata McGraw Hill, 2017, ISBN-13 978-1259004605 : 2. J.Das, S. K. Mullick, P. K. Chatterjee; Principles of Digital Communication; John Wiley 1986, ISBN-13: 978-0470202401 3. Bernard Sklar; Digital Communications: Fundamental & Applications, 2nd Edition; Pearson Education, 2001, ISBN-13 978-0130847881 : 4. Ranjan Bose; Information Theory, Coding & Cryptography, 2nd Edition; Tata McGraw Hill Publishing Company Limited.2008, ISBN-13 978- : 0070669017
Course Outcomes:	The student shall have the ability to CO 1. Explain the concepts related to information theory and coding techniques in communication systems. CO 2. Apply information theory and coding techniques in data transmission applications. CO 3. Analyze the performance of channel capacity and coding techniques. CO 4. Evaluate the channel capacity and the performance of different coding schemes in communication theory.

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Name of the Programme : **Electronics Communication and Instrumentation Engineering**
Course Code : **ECE-503**
Title of the Course : **Information Theory and Coding Lab**
Number of Credits : **01(1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of: 1. Basic programming skills in Python/MATLAB 2. Basic Linear Algebra including matrix operations.	
Course Objectives:	The course aims to provide the student with: 1. Understanding of the concepts of entropy, source coding and error control coding in information theory. 2. Knowledge of performance metrics and evaluation of encoders in different communication channels. 3. Programming skills necessary to implement typical source and error control coding schemes. 4. Knowledge to develop efficient algorithms to improve error performance in communication channels.	
Content:		**No of hours**
	List of Experiments: 1. Write a program for determination of joint entropy of a given channel. 2. Write a program for determination of conditional entropy of a given channel. 3. Write a program for the determination of mutual information of a given channel. 4. Write a program for the determination of channel capacity of a Binary symmetric and binary erasure channel. 5. Write a program to find the channel capacity of a Gaussian channel. 6. Write a program for generation and evaluation of variable length source coding for Shannon – Fano coding and decoding. 7. Write a program for generation and evaluation of variable length source coding for Huffman Coding and decoding. 8. Write a Program for coding & decoding of Linear block codes. 9. Write a Program for coding & decoding of Cyclic codes. 10. Write a program for coding and decoding of Convolutional codes.	**30**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Herbert Taub, Donald Schilling, and Goutam Saha, Principles of Communication Systems, Third Edition, Tata McGraw Hill, 2017, ISBN-13 978-1259029851 : 2. Ranjan Bose; Information Theory, Coding & Cryptography, 2nd Edition; Tata McGraw Hill Publishing Company Limited.2008; ISBN-13 978- : 0070669017	

Course Outcomes:	The student shall have the ability to CO 1. Develop algorithms to implement source coding techniques. CO 2. Design error control coding schemes for error detection and correction in noisy communication channels. CO 3. Develop algorithms to implement error control coding schemes. CO 4. Evaluate the performance of source and error control coding schemes using simulation tools.

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Programme Specific Elective (PSE) Courses

Name of the Programme : Electronics Communication and Instrumentation Engineering

Course Code : ECE-531

Title of the Course : Image Processing and Machine Vision

Number of Credits : 04 (3L +1T)

Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of basics of image processing	
Course Objectives:	The course aims to provide the student with: 1. An understanding of basic principles of Image Processing and Machine Vision. 2. Knowledge to analyse the various transformations in Image Processing and Machine Vision. 3. Knowledge to evaluate various Image Analysis techniques. 4. Capacity to solve problems related to Image Processing and Machine Vision task.	
Content:		**No of hours**
Unit -1	Light and Electromagnetic Spectrum, A Simple Image Formation Model, Image Sampling and Quantization, Representing Digital Images, Spatial and Intensity Resolution, Basic Relationship between Pixels, Basic Mathematical Tools used in Image Processing. The Basics of Intensity Transformations and Spatial Filtering, Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing and Sharpening Filters.	**12 + 4T**
Unit -2	Camera Geometry: Camera Projections, Projective Geometry, Reconstruction from more than one view, Euclidean Reconstruction, Auto-Calibration, Stereopsis. Image Formation: Radiometry – Measuring Light: Light in Space and at Surfaces, Important Special Cases, Sources, Shadows and Shading: Radiometric Properties of Light Sources, Qualitative Radiometry, Sources and their Effects, Local Shading Models, Photometric Stereo, Interreflections.	**11 +4T**
Unit -3	Geometric Image Features: Differential Geometry: Curves, Surfaces, Contour Geometry: The Occluding Contour and the Image Contour. Analytical Image Features: Analytical Euclidean Geometry: Coordinate Systems and Homogenous Coordinates, Coordinate System Changes and Rigid Transformations, Geometric Camera Parameters: Intrinsic, Extrinsic, Characterization of Perspective Projection Matrices, Calibration Methods.	**11+4T**
Unit- 4	Segmentation Using Clustering Methods: Shot Boundary Detection, Background Subtraction, Simple Clustering Methods, Segmentation using Simple Clustering Methods Fitting: The Hough Transform, Fitting Lines, Fitting Curves Finding Templates using Classifiers: Classifiers, Feature	**11 + 3T**

	Selection, Neural Networks Ethics in Machine Vision	
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 4th Edition, Pearson Education, 2018; l ISBN-13: 978-9353062989 2. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press 2003; ISBN-13: 978-0521540513 3. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson India, 2015; ISBN-13: 978-0136085928 4. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, Springer 2021; ISBN-13: 978-1848829343 5. Simon J. D. Prince, Computer Vision: Models, Learning and Inference, Cambridge University Press 2011; ISBN-13: 978-1107011793 6. Emanuele Trucco, Alessandro Verri, Introductory Techniques for 3-D Computer Vision, Prentice Hall 1998; ISBN-13: 978-0132611084	
Course Outcomes:	The student shall have the ability to CO 1. Describe and apply the basic principles of Image Processing and Machine Vision. CO 2. Analyse the relationships and transformations in Image Processing and Machine Vision. CO 3. Compare various Image Analysis techniques in Image Processing and Machine Vision. CO 4. Develop a pseudocode for a given Image Processing and Machine Vision task.	

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Name of the Programme : **Electronics Communication and Instrumentation Engineering**
Course Code : **ECE-532**
Title of the Course : **Next Generation Communication Systems**
Number of Credits : **04 (3L+ 1T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Knowledge of Basic Communication Engineering including the concept of Modulation and Multiplexing.	
Course Objectives:	The course aims to provide the student with: 1. Familiarization with 5G New Radio concepts and numerology related to development in 3GPP standards. 2. Understanding of New Radio architecture and protocols. 3. Knowledge of Cellular IoT architecture and associated functionalities. 4. Introduction to 6G and technical requirements for design of next generation communication systems.	
Content:		**No of hours**
Unit -1	**Fundamentals of 5G Cellular Systems:** **5G Standardization:** ITU-R Activities From 3G to 5G, 5G and IMT-2020, 3GPP Standardization. **Spectrum for 5G:** Frequency Bands for New Radio (NR), Long Term Evolution- Spectrum Flexibility, Multi-Antenna Enhancements, Densification, Small Cells, and Heterogeneous Deployments, New Scenarios- Machine Type Communication, Device-to-Device Communication, V2V and V2X.	**12 + 4T**
Unit -2	**5NR:** NR Basics in 3GPP Release 15, NR Evolution in Release 16 and 17, 5G Advanced Evolution in Release 18, Radio Interface Architecture- Overall System Architecture, Quality-of-Service Handling, Radio Protocol Architecture.	**11 + 4T**
Unit -3	**Fundamentals of 6G Cellular Systems:** 6G use cases, requirements, KPI targets, performance metrics, 6G enabling technologies, Millimeter-wave and Terahertz Spectrum for 6G Wireless- Introduction to mmWave and THz spectrum, Propagation at mmWave and THz frequencies, Beamforming and Antenna Patterns, Mmwave Communication Systems- Key design implications and potential applications of mmWave communications in 6G, THz Communication Systems- Potential applications of mmWave communications in 6G, Nano-networks.	**11+ 4T**
Unit- 4	**Cellular IoT:** New Applications and Requirements, Low Power Wide Area Networks, NB-IoT- 3GPP Standardization, Radio Access Design Principles, Release 14 Improvements, Radio Technologies for Unlicensed Spectrum- Short-Range Radio Solutions, Long-Range Radio Solutions, Comparison of Cellular IoT Technologies based on Coverage and Data Rate, Latency, Battery Lifetime, Device Complexity, Capacity, Deployments.	**11 + 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive	

Issued on: 04/11/2024

	learning and Collaborative learning
References/ Readings:	1. Erik Dahlman, Stefan Parkvall, Johan Skold, '5G NR The Next Generation Wireless Access Technology', Second Edition 2020, Academic Press, ISBN: 978-0-12-822320-8. 2. Yulei Wu, et. al., '6G Mobile Wireless Networks', 2021, Springer, ISBN: 978-3-030-72776-5. 3. Olof Liberg, et. al., 'Cellular Internet of Things Technologies, Standards, and Performance', 2018, Academic Press, ISBN: 978-0-12-812458-1. 4. Jonathan Rodriguez, 'Fundamentals of 5G Mobile Networks', 2015, John Wiley & Sons, Ltd, ISBN: ISBN: 9781118867525. 5. Saim Ghafoor, Mubashir Husain Rehmani, Alan Davy, 'Next Generation Wireless Terahertz Communication Networks', 2012, Taylor & Francis Group, 5th edition, ISBN: 9780367770426. 6. Xingqin Lin, Namyoon Lee, '5G and Beyond- Fundamentals and Standards', 2021, Springer, ISBN: 978-3-030-58196-1.
Course Outcomes:	The student shall have the ability to CO 1. Explain the guiding principles behind the design of next generation communication systems. CO 2. Compare the performance of contemporary communication systems for various use cases. CO 3. Characterize Millimeter-wave and Terahertz radio communication channels for next generation cellular communication systems including advanced 5G and beyond. CO 4. Investigate research solutions for challenges envisaged in deployment of next generation communication systems.

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Research Specific Elective (RSE) Courses

Name of the Programme : Electronics Communication and Instrumentation Engineering
Course Code : REC-561
Title of the Course : Engineering Research & Publications
Number of Credits : 4 (3L +1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review, defining the research objectives. 2. Explain qualitative and quantitative methods of data analyses and its importance. 3. Classify research publications, select appropriate journals based on research areas. 4. Practice ethics in publication and academic integrity	
Content:		**No of Hours**
Unit -1	**Overview of scientific research in engineering**, foundational and fundamental concepts like types of research and considerations for research in specific domains, motivation to do research, critical thinking, assumptions and hypotheses, basic and applied research, importance of formulation of broad research objectives	**11 + 4T**
Unit -2	**Purpose and Methodology of Literature Search and Review** of the scientific and engineering publications. Sources such as scholarly databases, public domain, open access, current literature, review articles, critical review and gap analysis, defining research objectives	**11 +4T**
Unit -3	**Quantitative and qualitative Data –** importance of data in research, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**12 +4T**
Unit- 4	**Preparation of Publications-** Elements of research publications, types of publications, writing for journal publications, basic requirements for publication, selection of journals, journal quality indicators, peer review, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity	**11+ 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 2. Michael Jay Katz, 'From Research to Manuscript', Springer	

	Publication, 2009, ISBN:9781402094668. 3. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work', Springer Publications, 2022, ISBN:9783030900243 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review, defining the research objectives. CO 2. Explain qualitative and quantitative methods of data analyses and its importance. CO 3. Classify research publications, select appropriate journals based on research areas. CO 4. Practice ethics in publication and academic integrity

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Name of the Programme : **Electronics Communication and Instrumentation Engineering**
Course Code : **REC-562**
Title of the Course : **Literature Review & Technical Writing for Engineers**
Number of Credits : **4 (3L +1T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review and writing a review paper. 2. Explain the method to be followed to write a review paper. 3. Classify data for qualitative and quantitative analysis 4. Demonstrate technical writing for conference.	
Content:		**No of Hours**
Unit -1	**Overview on Literature Review**, difference between objectives of literature review and research objectives; types of literature review, qualitative and quantitative reviews, search strategies, primary and secondary sources, database search strategies, field search, root search, complimentary search, meta-analysis	**12 + 4T**
Unit -2	**Database management of literature reviews**, bibliometric analysis, importance of writing a review paper, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity; public domain, open access, current literature.	**11+ 4T**
Unit -3	**Technical writing on a specific research topic**, structure of the paper, abstract, introduction, experimental, simulation, analysis, discussion, inferences, title, acknowledgment, referencing, presentation of tables, figures, graphs, equations; comparison between technical writing for conference papers and journal paper	**11+4T**
Unit- 4	**Importance of data in research**, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**11+3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work – Multidisciplinary Guide to Systematic Approaches', Springer Publications, 2022, ISBN:9783030900243. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668. 3. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486.	

	4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review and writing a review paper. CO 2. Explain the method to be followed to write a review paper. CO 3. Classify data for qualitative and quantitative analysis CO 4. Demonstrate technical writing for conference.

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