Master of Technology in **Wireless and Optical Communications**

Department of Electronics & Communication Engineering

Malaviya National Institute of Technology Jaipur

Subject Code	Course Title	Credit Total (L T P)
Semester 1 (Core Courses)		
ECT661	Advanced Digital Communication Systems	3 (3-0-0)
ECT663	Advanced Error Control Codes	3 (3-0-0)
ECT665	Wireless Communications	3 (3-0-0)
ECT679	Advanced Optical Communication Systems	3 (3-0-0)
ECT686	Photonic Integrated Devices and Systems	3 (3-0-0)
ECP667	Comm. Lab-I	3 (0-0-6)
ECT990	Mathematical Methods & Techniques for ECE technologists-I*	3 (3-0-0)
ECT992	Mathematical Methods & Techniques for ECE technologists-II*	3 (3-0-0)
	Total Semester Credits	**21**
Semester 2 (2 + 5 electives)		
ECP668	Comm. Lab-II	3(0-0-6)
ECD666	Minor Project	4(0-0-8)
	(Elective Courses)#	
ECT655	Optical Codes and Applications	3 (3-0-0)
ECT656	Adaptive Signal Processing	3 (3-0-0)
ECT657	VLSI signal processing architectures	3 (3-0-0)
ECT662	Advanced Digital Signal & Image Processing	3 (3-0-0)
ECT664	Estimation and Detection	3 (3-0-0)
ECT670	Satellite Communication and Radar Engg.	3 (3-0-0)
ECT672	Wireless and Mobile Adhoc Networking	3 (3-0-0)
ECT674	Cryptography	3 (3-0-0)
ECT676	Design of Microstrip Antennas	3 (3-0-0)
ECT678	Design of MIC's & MMIC's	3 (3-0-0)
ECT680	Advanced Mobile Systems	3 (3-0-0)
ECT682	Smart and Phased Array Antenna Design	3 (3-0-0)
ECT684	Advanced topics in Communication	3 (2-0-2)
ECT666	Optical Networks	3 (3-0-0)
ECT689	Photonic Switching	3 (3-0-0)
ECT690	Wireless Sensor Networks	3 (3-0-0)
ECT692	Computational Electromagnetics	3 (3-0-0)

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ECT694	Advanced Photonic Devices and Components	3 (3-0-0)
ECT696	Telecomm. Technology & management	3 (3-0-0)
ECT698	Advanced Networking analysis	3 (3-0-0)
Optional Electives (Over and Above)		
ECT681	Special Modules in WOC – I	1 (1-0-0)
ECT 683	Special Modules in WOC – II	1 (1-0-0)
ECT685	Special Modules in WOC – III	1 (1-0-0)
ECT687	Special Modules in WOC – IV	1 (1-0-0)
	Total Semester Credits	**22**
Semester 3		
ECD659	Dissertation	16(0 0 32)
	Total Semester Credits	**16**
Semester 4		
ECD660	Dissertation	16(0 0 32)
	Total Semester Credits	**16**
	Total Credits of all semesters	**73**

#The students may opt for *any course from MTech (**WOC**) and selected courses form other MTech streams* in the Institute/department on recommendation of supervisor
*****Only one course out of ECT990 or ECT992 shall be opted by a student

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Program: M Tech (ECE)	**Department: Electronics & Communication Engineering**
Course Code: ECT661	**Course Name: Advanced Digital Communication Systems**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Unit 1: **Review:** Signals and Systems with focus on Random Signals, Sampling Theorem, Signal Space and Constellation Diagrams and Orthogonal Signal Sets. **Baseband modulation and Demodulation:** Detection of binary signals in Gaussian Noise, ISI, Equalization, Carrier and symbol synchronization, and Signal Design for bandlimited channels.

Unit 2: **Bandpass modulation and Demodulation:** Modulation Techniques, Coherent and Non Coherent Detection, Error performance for binary system, and Symbol error performance for M-ary systems.

Unit 3: **Communication link analysis:** Link budget analysis, Simple link analysis, system trade-offs, and Modulation-coding trade-offs.

Unit 4: **Spread Spectrum:** signal PN sequences, DS-CDMA, FH-CDMA, and Jamming consideration. **Communication through Fading Channels**

References:

1. Sklar, Digital Communications, Pearson
2. Proakis, Digital Communications, TGMH.
3. B.P. Lathi, Modern Digital and Analog Communication, OUP

Course Outcomes:

CO1. To apply mathematics in the analysis and design of a digital communication system.
CO2. To mathematically analyse the role and effects of noise.
CO3. To study different modulation schemes in terms of error performance and bandwidth requirement.
CO4. To improve the performance of a system using advanced communication techniques.
CO5. To mathematically characterize the effects of the communication link.

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Program: M Tech (ECE)	Department: Electronics & Communication Engineering
Course Code: ECT663	Course Name: Advanced Error Control Codes
Credit: 3	L-T-P: 3-0-0
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Error Control coding for wireless fading channels, Channel Estimation and Adaptive channel coding, Joint Source and Channel coding . Non binary Linear Block Codes, Hard and soft decision decoding, Coding and Decoding of BCH, Reed Solomon Codes, Convolution codes: Coding and Decoding , Distance bounds, Performance bounds Turbo codes: Coding, Decoding Algorithms, Performance comparison , Interleaver design Trellis coded Modulation, TCM Decoders, TCM for AWGN and Fading Wireless Channels, Performance comparison.

LDPC Codes, Polar Codes, Error control codes for : Audio/video transmission, mobile communications, space and satellite communication, data transmission, data storage and file transfer.

References:

1. Stephen G. Wilson; Digital Modulation & Coding;. Prentice Hall Inc.

2. Ranjan Bose; Information Theory Coding and Cryptography, TMH

3 .Blahut R.E. , Theory and practice of error control codes, AWL1983.

4. J.G.Proakis; Digital Communication.

Course Outcomes:

CO1. Appreciate the need of Error Correction in communication systems after going through the course
CO2. Develop requisite mathematical background for Error Correction using linear algebra
CO3. Design error correcting codes using mathematical models
CO4. Design encoders and decoders for a given error correcting capability
CO5. Validate theoretical results with simulation results
CO6. Use MATLAB software for simulation (TT)

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Program: M Tech (ECE)	Department: Electronics & Communication Engineering
Course Code: ECT665	**Course Name: Advanced Microwave Engineering**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Unit 1: Review of Electromagnetic Theory, Transmission Lines and Waveguides, Impedance Matching and Tuning

Unit 2: Introduction to Baritt, Trapatt, Gunn diode, Pin diode and other microwave solid state devices.

Unit 3: Introduction to Microstrip lines, Parallel Striplines and other striplines. Slot lines, Integrated Fin line, Non-radiative guide, Transitions, Bends and Discontinuities.

Unit 4: Microwave amplifiers and oscillators. Measurement of VSWR, impedance, frequency, dielectric constant power, attenuation, power and other microwave circuit performance parameters.

Unit 5: Microwave amplifiers and oscillators. Measurement of VSWR, impedance, frequency, dielectric constant power, attenuation, power and other microwave circuit performance parameters.

References:

1. Microwave Devices and Circuits- Samuel Y. Liao, Prentice Hall
2. Microwave engineering-David M. Pozar, John Wiley & Sons, Inc.
3. Microwave Solid State Circuit Design- Inder Bahl, John Wiley & Sons.
4. Microwave circuits & passive devices- Sisodia and Raghuvanshi, New Age International.
5. Foundations of Microwave Engg.- Collin, John Wiley and Sons.
6. Microwave and Radar Engineering- Kulkarni, McGraw Hill Education
7. Introduction to Microwaves –Wheeler G.J., Prentice-Hall

Course Outcomes:

CO1. Evaluate various parameters of transmission lines and waveguides
CO2. Explain and evaluate performance of multiport microwave networks
CO3. Describe the working principles of different microwave solid state devices.
CO4. Explain different types of planar transmission lines and discontinuities.
CO5. Explain the working principles of microwave amplifiers and oscillators.
CO6. Compute the measurement parameters such as VSWR, impedance, frequency, dielectric constant power, attenuation and phase shift etc related to microwave circuits

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Program: M Tech (ECE)	**Department: Electronics & Communication Engineering**
Course Code: ECT679	**Course Name: Advanced Optical Communication Systems & Networks**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Review of optical fiber waveguiding concepts, Advanced fiber design: Dispersion issues, Dispersion shifted, Dispersion flattened, Dispersion compensating fiber, Design optimization of single mode fibres. Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and soliton based communication.
Transmitter design, Receiver - PIN and APD based designs, noise sensitivity and degradation. Receiver amplifier design. Transceivers for fiber optic communication pre amplifier type- optical receiver performance calculation - noise effect on system performance receiver modules.
Coherent, homodyne and heterodyne keying formats, BER in synchronous- and asynchronous-receivers, sensitivity degradation, system performance, Multichannel, WDM, multiple access networks, WDM Components, TDM, Subcarrier and Code division multiplexing. Semiconductor laser amplifiers, Raman - and Brillouin - fiber amplifiers, Erbium doped fiber amplifiers, pumping phenomenon, LAN and cascaded in-line amplifiers. Limitations, Post- and Pre-compensation techniques, Equalizing filters, fiber based gratings, Broad band compression.
Next Generation Optical Communications: Multi-core MMF based SDM transmission, Optical wireless communications.
Optical networks- Basic networks-SONET/ SDH-wavelength routed networks - Nonlinear effects on network performance, performance of various systems (WDM, DWDM + SOA).

References:

1) Fiber-Optic Communication Systems by Govind P. Agrawal
2) Franz and Jain, "Optical communication systems", Narosa Publications, New Delhi, 1995
3) Online Resource: https://nptel.ac.in/courses/117101002/

Course Outcomes:

CO1. Develop understanding of design concepts related to optical including dispersion and its compensation, GVD, Dispersion shifted, Dispersion flattened and Dispersion compensating fibers, non-linear effects.
CO2. Design Optical Communication systems including power and rise time budget analysis, component selection, Transmitters, Receivers and amplifiers and evaluate their performance.
CO3. Analyze different modulation schemes along with their system performance, various detection schemes.
CO4. Appreciate Multichannel, multiple access networks and multiplexing techniques, optical network protocols such as SONET/SDH, WDM and DWDM.
CO5. Evaluate the performance of optical communication systems under high power conditions including non-linear effects, FWM.

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Program: M Tech (ECE)	Department: Electronics & Communication Engineering
Course Code: ECT686	**Course Name: Photonic Integrated Devices and Systems**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Planar waveguides: Step-index and graded-index waveguides, guided and radiation modes. Strip and channel waveguides, anisotropic waveguides, segmented waveguide; electro-optic and acousto-optic waveguide devices. Directional couplers, optical switch; phase and amplitude modulators, filters, etc. Y-junction, power splitters, Arrayed waveguide devices, fiber pig tailing, Fabrication of integrated optical waveguides and devices. Waveguide characterization, end-fire and prism coupling; grating and tapered couplers, nonlinear effects in integrated optical waveguides.

New materials and process technologies for optical device fabrication, advanced optical sources & detectors, amplifiers, their reliability issues, Polymer waveguides, Surface Plasmon Devices, Optical integrated circuits, hybrid & monolithic systems, optical interconnects, materials and processing for OEIC.

References:

1. Integrated Optics, by Robert G. Hunsperger, Springer
2. Integrated Photonics: Fundamentals, By Ginés Lifante, John Wiley and Sons

Course Outcomes:

CO1. Develop understanding of design concepts related to optical planar waveguides, directional couplers and switches.

CO2. Analyze and Design components such as WDM couplers, filters, isolators, circulators, photonic crystal based waveguides.

CO3. Explore new materials and process technologies for optical device fabrication, reliability issues.

CO4. Develop understanding of design concepts related to hybrid and monolithic systems, optical interconnects.

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Program: M Tech (ECE)	Department: Electronics & Communication Engineering
Course Code: ECT990	**Course Name: Mathematical Methods and techniques for Electronics & Communication Technologists-I**
Credit: 3	**L-T-P: 3-0-0**
Pre-requisite Course:	
Co-requisite Course:	

Syllabus:

Advancements in Transforms: Discrete Fourier Transform, FFT, Short time Fourier Transform (STFT), Multi Resolution Analysis, Wavelet Transform, Continuous Wavelet Transform (CWT), Inverse CWT, Discrete Wavelet Transform, Sub-band coding and implementation of DWT, Applications (signal and image compression, de-noising, detection of discontinuous and breakdown points in signals), Discrete Cosine Transform, Stockwell-transform, Frequency selective filtering with wavelet and S-transform.

Modelling: Direct Modeling (identification), Inverse Modeling(Equalization), Classification and Clustering, Prediction/Forecasting, Auto regressive models (AR, MA, ARMA).

Optimization: Problem formulation, Linear Programming Problems, Solution by Graphical Methods, Symmetric Dual Problems, Slack and Surplus Variables, Simplex Method, Convex- Concave Problems.

Data Mining Techniques: Higher Order Statistics, Principal Component Analysis, Linear Discriminant Analysis, Independent Component Analysis

References:

1. Digital Signal Processing: Principles, Algorithms, and Applications 4 Edition, Author: John G. Proakis, Dimitris G Manolakis Publisher: Pearson.
2. Wavelets and Signal Processing, Author: Hans-Georg Stark, Publisher: Springer
3. The Wavelet Tutorial : The Engineer's Ultimate Guide to Wavelet Analysis, Author : Robi Polikar, University of Rowan : Online : http://users.rowan.edu/~polikar/WTtutorial.html
4. Stockwell, Robert Glenn, Lalu Mansinha, and R. P. Lowe. "Localization of the complex spectrum: the S transform." IEEE Transactions on Signal Processing 44.4 (1996): 998-1001.
5. Engineering Optimization: Theory and Practice, Third Edition SINGIRESU S. RAO, New Age Publishers
6. Data Mining - Concepts and Techniques, Authors : Jain Pei, Jiawei Han, Micheline Kamber, Publisher : Elsevier

Course Outcomes:

CO1. To learn the advancement in transforms
CO2. To understand the mathematical modeling and optimization techniques.
CO3. To learn the data mining techniques
CO4. To explore the engineering applications of the mathematical techniques.
CO5. To develop MATLAB and other programming skills for the mathematical techniques realization.

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Program: M.Tech. (ECE)	**Department: Electronics & Communication Engineering**
Course Code: ECT 992	**Course Name: Mathematical Methods and techniques for Electronics & Communication Technologists-II**
Credit:3	**L-T-P: 3-0-0**
Pre-requisite course:	
Co-requisite Course:	

Syllabus:

[The following contents intend to cover implicit application to and exemplification through ECE problems in Electronic systems/Cognitive-systems domain such as reduced order polynomials, order reduction of a transfer function, sparse matrix based solution of large systems, discrete structures, implementation of search algorithms for design space exploration, and computer arithmetic implementation along with probabilistic reasoning for AI]

A. (i) (a) Large Matrix analysis and large Eigen value problem– Groups, fields and rings; vector spaces; basis & dimensions; canonical forms; inner product spaces- orthogonalization, Gram-Schmidt orthogonalization, unitary operators, change of orthonormal basis, diagonalization; (b) Eigenvalues & eigen vectors- Gerschghorin theorem, iterative method, Sturm sequence, QR method, introduction to large Eigen value problems. 08 Hrs.

(ii) Reduced order modelling of systems- Taylor's polynomial, least square approximation, Chebyshev series/polynomial, splines, Pade & rational approximation 04 Hrs.

B. Discrete Structures, graphs, algorithms & Combinatorial optimization- counting methods, algorithm analysis, graph algorithms, dynamic algorithms, randomized algorithms, probabilistic algorithms, combinatorial optimization16 Hrs.

C. (i) Number theory & computer arithmetic- unconventional number systems, residue number system, logarithmic number system, Chinese remainder theorem; fast evaluation of elementary & transcendental arithmetic functions. 06 Hrs.

(ii) Preface to AI- first order logic & inferencing, uncertainty, probabilistic reasoning systems, making decisions under uncertainty; **08 Hrs.**

Suggested references (not limited to)-

1. Schaum's outline on Linear Algebra, McGraw Hill
2. Topics in Algebra, I. N. Herstein, Wiley.
3. Gerald, C F; Wheatley P O; Applied Numerical Analysis, Pearson, 2017
4. Theory and Applications of Numerical Analysis, G. M. Phillips, Peter J. Taylor, Academic press
5. Advanced Model Order Reduction Techniques in VLSI Design, Sheldon Tan, Lei He, Cambridge Univ. Press, 2007.
6. Cormen, Rivest, Leiserson, Introduction to Algorithms, PHI
7. Combinatorial optimization, Papadimitriou and Steiglitz, PHI (I)
8. Russel and Norvig- Artificial Intelligence: A Modern Approach, Pearson, 3rd Ed. 2017
9. Israel Koren, Computer Arithmetic- Academic Press
10. Model Order Reduction: Theory, Research Aspects and Applications edited by W. H. A. Schilders, Henk A. Van Der Vorst, Joost Rommes, Springer.
11. Discrete Structures, Schaum outline

Further references

1. MODEL ORDER REDUCTION TECHNIQUES WITH APPLICATIONS IN ELECTRICAL ENGINEERING**,** Luigi FORTUNA, Guiseppe NUNNARI, Antonio GALLO, Springer, 1992.
2. Y. Saad, Numerical methods for large Eigenvalue problems, www.umn.edu
3. Matrix Analysis & linear algebra, Meyer, SIAM
4. H. A. van der Vorst, Iterative methods for large linear systems, citeseerx.ist.psu.edu
5. Cheng et al, Symbolic analysis and reductions of VLSI circuits, Springer, 2005

Course Outcomes:

CO1. Is able to grasp core concepts, basic tenets of linear algebraic structures- groups, fields and rings;vector spaces (knowledge)

CO2. Is able to grasp features, properties and operations on vector spaces- orthogonalization, change of basis, diagonalization (knowledge)

CO3. Is able to learn & apply problem solving for computing eigen values and eigen vectoraetc. (Thinking, skills)

CO4. Is able to demonstrate application of algorithms (Gerschgorin, Sturm sequence method, QR method) for eigen value computation/estimation and MATLAB validation(skills)

CO5. Is able to describe algorithms for function approximation (rational, Chebychev, Pade etc.) using MATLAB (skills)

CO6. Develops appreciation for combinatorial optimization algorithms, AI probabilistic approaches & implements through MATLAB/C++ (skills)

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