NATIONAL INSTITUTE OF TECHNOLOGY
ANDHRA PRADESH

SCHEME OF INSTRUCTION AND SYLLABI
B.Tech. – Electronics & Communication Engineering
Effective from 2020-21

NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

Vision of the Department of ECE:

To strive for excellence in academics, research and technological service to the society, with an intent to nurture the stakeholders and produce Computer Scientists, technologists and Engineers who are globally competent and nationally relevant.

Mission of the Department of ECE:

To adopt a teaching-learning process that imparts technical skills and state-of-the-art knowledge with a well-blended and balanced mix of theory and practice.

M 1. To create functional centres of excellence that promote research and consultancy in the thrust sub-domains of theoretical computer science, systems and technology.

M 2. To collaborate with industry and higher learning institutes of national/international repute and solve socially relevant problems.

Programme Educational Objectives (PEOs) for the B.Tech. (ECE) Programme:

Within few years after the end of the B.Tech. in Computer Science and Engineering programme, graduates will be able to:

PEO1	Gain good foundations in the field of Electronics and Communications and make abreast of the knowledge in handling real-world challenges that mankind faces in this field.
PEO2	Enhances the skills by self-learn and research by establishing, representing and analysing the problem
PEO3	Architect the modern technological world by enhancing the skillset in the Electronics and Communications related fields and exhibiting it in more effective and efficient way.

Programme Articulation Matrix (PEO vs. Mission) for the B.Tech. (ECE) Programme:

PEO\Mission	M1	M2	M3
PEO1	S	M	S
PEO2	S	S	M
PEO3	M	S	S

S: Strong correlation, M: Medium correlation, L: Low correlation

Programme Outcomes (POs) for the B.Tech. (ECE) Programme:

At the end of any B.Tech. program in NIT Andhra Pradesh, graduates will be able to:

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSO) for the B.Tech. (ECE) Programme:

At the end of the B.Tech. in Computer Science and Engineering programme, graduates will be able to:

PSO1	Analyze and design of electronic circuits and Communication systems to enhance the quality of human life
PSO2	Develop innovative and environment-conscious technologies to sustain human life

Degree Requirements for B.Tech. (ECE) Programme

	Proposed Credits (New regulation)
Basic Science Core (BSC)	**19 (11.72%)**
Engineering Science Core (ESC)	**22 (13.58%)**
Humanities and Social Science Core (HSC)	**06 (3.7%)**
Program Core Courses (PCC)	**63 (38.88%)**
Departmental Elective Courses (DEC)	**15 (9.25%)**
Open Elective Courses (OPC)	**09 (5.55%)**
Program Major Project (PRC)/Skill Development (SD)/Foreign Languages	**22 (13.58%)**
EAA: Games and Sports (MSC)	**2 (1.23%)**
MOOCs (MOE)	**4 (2.46%)**
Total	**162**

Choice Based Credit System: 26.54 %

NOTE: The minimum no. of credits required to award B.Tech. degree is 162 as per the proposed curriculum.

Credit Distribution in Each Semester										
	I	II	III	IV	V	VI	VII	VIII	TOT	REQ
BSC	8	8	3	0	0	0	0	0	**19**	**≥ 19**
ESC	4	10	4	4	0	0	0	0	**22**	**≥ 14**
HSC	3	0	0	0	0	0	3	0	**6**	**≥ 06**
PCC	0	0	13	16	16	11	7	0	**63**	**≥ 62**
DEC	0	0	0	0	0	6	6	3	**15**	**≥ 15**
OPC	0	0	0	0	3	3	0	3	**9**	**≥ 09**
PRC/ SD	5	2	0	2	0	3	4	6	**22**	**≥ 15**
EAA (MSC)	1	1	0	0	0	0	0	0	**2**	**≥ 2**
MOOCS (MOE)	0	0	0	0	2	0	0	2	**4**	**≥ 4**
	21	**21**	**20**	**22**	**21**	**23**	**20**	**14**	**162**	

I Year B.Tech. Course Structure

(Common for all branches)

Physics Cycle							
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA101/ MA151	Differential and Integral Calculus / Matrices and Differential Equations	3	0	0	**03**	**BSC**
2	HS101	English for Technical Communication	2	0	2	**03**	**HSC**
3	PH101	Engineering Physics	3	0	0	**03**	**BSC**
4	EC101	Basic Electronics Engineering	2	0	0	**02**	**ESC**
5	CE102	Environmental Science and Engineering	2	0	0	**02**	**ESC**
6	CS101	Introduction to Algorithmic Thinking and Programming	3	0	0	**03**	**SD**
7	CS102	Introduction to Algorithmic Thinking and Programming Lab	0	1	2	**02**	**SD**
8	PH102	Engineering Physics Lab	0	1	2	**02**	**BSC**
9	EA101/ EA151	Physical Education/Health Education	0	0	3	**01**	**MSC**
		TOTAL	**15**	**2**	**9**	**21**	

Chemistry Cycle							
S. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA101/ MA151	Differential and Integral Calculus / Matrices and Differential Equations	3	0	0	**03**	**BSC**
2	ME102	Engineering Graphics with Computer Aided Drafting	0	1	2	**02**	**ESC**
3	CY101	Engineering Chemistry	3	0	0	**03**	**BSC**
4	EE101	Elements of Electrical Engineering	2	0	0	**02**	**ESC**
5	BT101	Biology for Engineers	2	0	0	**02**	**ESC**
6	ME101	Basics of Mechanical Engineering	2	0	0	**02**	**ESC**
7	CE101	Engineering Mechanics	2	0	0	**02**	**ESC**
8	ME103	Workshop Practice	0	1	2	**02**	**SD**
9	CY102	Engineering Chemistry Lab	0	1	2	**02**	**BSC**
10	EA101/ EA151	Physical Education/Health Education	0	0	3	**01**	**MSC**
		TOTAL	**14**	**3**	**9**	**21**	

Note:

BSC: Basic Science Core

ESC: Engineering Science Core

HSC: Humanities and Social Science Core

PCC: Program Core Courses

DEC: Departmental Elective Courses

OPC: Open Elective Courses

Program Major Project (PRC)/Skill Development (SD)/Foreign Languages

EAA (MSC): Games and Sports MOOCs (MOE)

II Year B.Tech. ECE Course Structure

Summer Internship – I#

Semester-III							
S. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA205	Complex Variables and Special functions	3	0	0	03	**BSC**
2	EC201	Network Analysis	3	1	0	04	**ESC**
3	EC202	Digital System Design	3	1	0	03	**PCC**
4	EC203	Signals and Systems	3	0	0	03	**PCC**
5	EC204	Electronic Devices and Circuits – I	3	0	0	03	**PCC**
6	EC205	Electronic Devices and Circuits –I lab	0	0	3	02	**PCC**
7	EC206	Digital System Design lab	0	0	3	02	**PCC**
		TOTAL	**15**	**2**	**6**	**20**	

Semester-IV							
S. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1.	CS285	Data Structures and Algorithms	2	1	2	04	**ESC**
2.	EC251	Electronic Devices and Circuits – II	3	0	0	03	**PCC**
3.	EC252	Probability Theory and Stochastic Processes	3	0	0	03	**PCC**
4.	EC253	Digital Signal Processing	3	0	0	03	**PCC**
5.	EC254	Transmission lines & Electromagnetic Waves	3	0	0	03	**PCC**
6.	EC255	Electronic Devices and Circuits – II lab	0	0	3	02	**PCC**
7.	EC299	Minor Project-I (EPICS)	0	0	3	02	**SD**
8.	EC256	Digital Signal Processing lab	0	0	4	02	**PCC**
		TOTAL	**14**	**4**	**8**	**22**	

Summer Internship – II#

III B. Tech. I Semester ECE Course Structure

S. No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.	EC301	Control Systems	3	0	0	03	PCC
2.	EC302	Analog & Digital Communications	3	0	0	03	PCC
3.	EC303	Linear IC Applications	2	0	2	03	PCC
4.	EC304	Microcontrollers	3	0	1	04	PCC
5.	EC305	Antennas Theory	3	0	0	03	PCC
6.		Open Elective – 1/ Foreign language	3	0	0	03	OPC/SD
7.	MEC301	MOOCS-1	2	0	0	02	MOE
		Total	**19**	**0**	**3**	**21**	

III B. Tech. II Semester ECE Course Structure

S. No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.	EC351	CMOS VLSI Design	3	0	0	03	PCC
2.	EC352	Embedded and Real Time Operating Systems	3	0	0	03	PCC
3.	EC353	Information Theory & Coding	3	0	0	03	PCC
4.		Department Elective-1	3	0	0	03	DEC
5.		Department Elective-2	3	0	0	03	DEC
6.	EC354	Communication Systems Lab	0	1	2	02	PCC
7.		Open Elective – 2/ Foreign language elective	3	0	0	03	OPC/SD
8.	EC399	Mini Project-II	0	0	6	03	SD
		Total	**18**	**1**	**8**	**23**	

Summer Internship – III#

#: The student can do Summer Internship with duration of minimum 45 days at Institutes / Organizations / Industries and produce the certificate of completion and copy of internship report to the department.

It is optional only, Not Mandatory.

IV B. Tech. I Semester ECE Course Structure (2021-2022)

S. No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.	SM430	Entrepreneurship for Engineering	3	0	0	03	HSC
2.		Department Elective –3	3	0	0	03	DEC
3.		Department Elective – 4	3	0	0	03	DEC
4.	EC401	Microwave and Light Wave Technologies	3	0	0	03	PCC
5.	EC402	Industry Related Subject	2	0	0	02	PCC
6.	EC403	Microwave and Light Wave Technologies lab	0	0	3	02	PCC
7.	EC449	Project work- Part A	0	0	8	04	PRC
		Total	**14**	**0**	**11**	**20**	

**: The PCC Subject may be offered with the support of Industry.

IV B. Tech. I Semester ECE Course Structure (2021-2022)

S. No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.		Department Elective – 5	3	0	0	03	DEC
2.		Open Elective	3	0	0	03	OPC
3.	MEC401	MOOCS-2	2	0	0	02	MOE
4.	EC499	Project-Work Part – B (with option of Industrial Training /Internship)	0	0	12	06	PRC
		Total	**8**	**0**	**12**	**14**	

*If the students are in Industrial training, the electives may be conducted online.

DAC approved NPTEL courses subject to the availability of the course.

MOOCS-1: Computational Electro Magnetics
Op-Amp Practical Applications: Design Simulation and Implementation.System
Design through VERILOG
Semi-Conductor Physics
AURDINO Microcontroller Programming

MOOCS-2: Pattern Recognition and Applications
Principles of Modern CDMA/MIMO/OFDM Wireless Communications
VLSI Design Verification and Test
Introduction to Biomedical Imaging Systems

Department Electives:

Department Elective 1: EC361 Data Networks
EC362 Optimization Techniques
EC363 IoT and Applications
EC364 Computer Architectures

Department Elective 2: EC365 Smart Antenna
EC366 Optical Communication
EC367 Fuzzy & Neural Networks
EC368 Electronics Instrumentation

Department Elective 3: EC411 Cellular and Mobile Communications
EC412 Satellite Communications
EC413 Digital Image Processing
EC 414 Low Power VLSI

Department Elective 4: EC415 Advanced Radar Technologies
EC416 Fundamentals of MIMO Wireless Communication
EC417 Introduction to Machine Intelligence
EC418 Software Defined and Cognitive Radio

Department Elective 5: EC461 Advanced Wireless Communication: 5G and Beyond
EC462 Forensic Signal and Image
EC463 VLSI Signal Processing
EC464 Microwave Integrated Circuits

Minor in Artificial Intelligence for Signal Processing Applications

Courses							
S. No	Course Code	Course Title	L	T	P	Credits	Offered Sem
1	ECM251	Statistical Foundations for Signal Processing and Machine Learning	4	0	0	4	4th
2	ECM301	Non-Linear Programming	3	0	3	3	5th
3	ECM351	Machine Learning for Signal Processing applications	4	0	0	4	6th
4	ECM401	Digital Modulation and Coding	3	0	0	3	7th
5	ECM402	AI for Signal Processing applications Lab	0	0	2	2	7th
		Total				**16**	

* Any PG Level course related to Data Science with the approval of DAC PG&R

Note:

1. A student is permitted to do either Minor or Honors only, but not both

2. A student is permitted to do only one Minor/ one Honors.

Courses for the award of B. Tech Degree with Honors (20 Credits)

Courses for Honors							
S.No	Course Code	Course Title	L	T	P	Credits	Offered Sem
1	ECH301	Wireless Communication	3	1	0	**04**	**5th**
2	ECH302	Detection and Estimation Theory	3	1	0	**04**	**5th**
3	ECH351	Advanced Signal Processing for Image and Video	3	1	0	**04**	**6th**
4		Course IV: MOOCs	3	1	0	**04**	**6th**
5		Course V: MOOCs	3	1	0	**04**	**7th**
		TOTAL	**15**	**5**	**0**	**20**	

MOOCS Courses: Basics of software defined Radios and Practical Applications Signal Processing for mm Wave communication for 5G and beyondDesign for internet of things
Cognitive Radio

I Year B.Tech. Course Structure
(Common for All Branches)

MA101	**Differential and Integral Calculus** I B.Tech. I Semester - all sections	**BSC**	**3-0-0**	**3 Credits**

Pre-requisites: None

Differential Calculus of functions of several variable: Review of Limit, continuity (sequential verification) and differentiability, Partial differentiation; Total differentiation; Euler's theorem and generalization; Change of variables- Jacobians; Maxima and minima of functions of several variables (2 and 3 variables); Lagrange's method of multipliers. (14)

Integral Calculus: Convergence of improper integrals; Beta and Gamma integrals; Differentiation under integral sign; Double and Triple integrals - computation of surface areas and volumes; change of variables in double and triple integrals. (14)

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directional derivative; gradient of a scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Green's theorem in a plane; Stokes' theorem; Gauss Divergence theorem. (14)

Text Reference:

1. Joel R. Hass, Maurice D. Weir, George B. Thomas, *Thomas' Calculus*, 12th edition, Pearson , 2010.
2. Erwin Kreyszig, *"Advanced Engineering Mathematics"*, Eighth Edition, John Wiley and Sons, 2015
3. B. S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publications, 2015
4. R. K. Jain and S. R. K. Iyengar, *"Advanced Engineering Mathematics"*, Fifth Edition, Narosa Publishing House, 2016.
5. T. M. Apostol, Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.

MA151	**Matrices and Differential Equations** I B.Tech. II Semester - all sections	**BSC**	**3-0-0**	**3 Credits**

Pre-requisites: Mathematics-I

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistency of the system of linear equations; Eigenvalues and eigenvectors of a matrix; Caley-Hamilton theorem and its applications; Reduction to diagonal form; Reduction of a quadratic form to canonical form - orthogonal transformation; Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices.

Ordinary Differential Equations of Higher Order: Higher order linear differential equations with constant coefficients - homogeneous and non-homogeneous; Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations; applications in physical problems - forced oscillations, electric circuits, etc.

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace transforms; Laplace transforms of unit step function, impulse function, periodic function; Convolution theorem, solving certain initial value problems, solving system of linear differential equations, finding responses of systems to various inputs viz. sinusoidal inputs acting over a time interval, rectangular waves, impulses etc.

Text Reference:

1. E. Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons, 2015.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Fifth Edition, Narosa Publishing House, 2016.
4. G. Strang, Linear Algebra and Its Applications, 4th Edition, Brooks/Cole India, 2006.
5. T. M. Apostol, Calculus, Volume 2 (2nd Edition), Wiley Eastern, 1980.

HS101	ENGLISH FOR TECHNICAL COMMUNICATION	SD	2 – 0 – 2	3 Credits

Pre-requisites: None.

Detailed syllabus

Grammar Principles and Vocabulary Building: -Exposure to basics of grammar- tenses—active and passive voice- their usage-Concord -Error Detection-Idioms and Phrases-Phrasal verbs—their meanings and usage, Synonyms and antonyms

Developing paragraphs using mind mapping- Definition- structure- Types and Composition-unity of theme- coherence- organization patterns-essays and their structure-note-making

Letter Writing: Formal letters-- communicative purpose-strategy- letter format and mechanics- letters of request, complaint and invitation-writing emails

Reading Comprehension –skimming-scanning-intensive and extensive reading-reading to retrieve information –—techniques of comprehension -find clues to locate important points- answering objective type questions–inference, elimination

Delegation- steps involved in delegation-preparing delegation for a program

Preparing Questionnaire-Determine audience and content of each question-response structure-develop wording for each question-establish sequence of questions

Profiling Readers-Audience analysis- Identifying potential audience- Identifying primary, secondary, tertiary readers, and gatekeepers- Identifying the needs, values, and attitude of the readers

Resume Writing-Writing for Professional Networking-Academic writing-research proposals-Interpretation of Graphs.

Technical Report-Writing - kinds of reports-proposals, progress and final reports- their structure-features- process of writing a report-editing.

Language Laboratory

Introduction to basic phonetics: Vowels, Consonants, Diphthongs, phonetic symbols

Listening: Challenges in listening, enhancing listening skills, listening activities

Speaking: JAM using cue cards-role play-Group presentation-presentation with emphasis on body language- public speaking-extempore speech

Group discussion: Dos and don’ts, intensive practice

Mock interview: Interview etiquette, common interview questions.

Text Books:

Emden, Joan van. *Effective Communication for Science and Technology*. Macmillan Education UK, 2001.

Mohan, Krishna and Meera Banerji. *Developing Communication Skills*. Macmillan India Limited, 2000.

Murphy, Raymond. *Intermediate English Grammar*. Cambridge University Press, 2014.

Narayanaswami, V. R. *Strengthen Your Writing*. Orient Longman Private Limited, 2005.

Soundaraj, Francis. *Speaking and Writing for Effective Business Communication*. Macmillan Publishers India Limited, 2007.

Ur, Penny. *Discussions that Work*. Cambridge University Press, 1981.

Reference:

Aarts, Bas. *Oxford Modern English Grammar*. Oxford University Press, 2011.

Anderson, Marilyn, Pramod K. Nayar, and Madhucchanda Sen. *Critical Thinking, Academic Writing and Presentation Skills*. Pearson Education, 2008.

Blake,Gary.*The Elements of Technical Writing*. Pearson,2000

Brown, Carla L. *Essential Delegation Skills*. Routledge, 2017.

Busan, Tony. *Mind Map Mastery*. Walkins, 2018.

Carlisle, Joanne and Melinda S. Rice. *Improving Reading Comprehension Research-based Principles and Practices*. York Press, 2002.

Carter, Ronald and Michael McCarthy. *Cambridge Grammar of English: A Comprehensive Guide*. Cambridge University Press, 2006.

Carter, Ronald, Rebecca Hughes, and Michael McCarthy. *Exploring Grammar in Context: Upper-intermediate and Advanced.* Cambridge University Press, 2000.

Eastwood, John. *Oxford Guide to English Grammar*. Oxford University Press, 1994.

Harris, David.F. *Complete Guide to Writing Questionnaires.* I& M Press, 2014.

Hering, Lutz and Heike Hering. *How to Write Technical Reports: Understandable Structure, Good Design, Convincing Presentation*. Springer; 2010.

HuckinN.Thomas and Leslie A.Olsen*Technical Writing and Professional Communication for Non-native Speakers*. McGraw-Hill Education,1991.

Laplante, Phillip A*. Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals.* CRC Press, 2018.

McQuail, Dennis. *Audience Analysis*. Sage, 1997

Ogden, Richard. *Introduction to English Phonetics*. Edinburgh University Press, 2017.

Parker, Glenn M. *Team Players and Teamwork: New Strategies for Developing Successful Collaboration*. Wiley, 2011.

Seely, John. *Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly*. Oxford University Press: 2013.

PH101	Engineering Physics	BSC	3-0-0	3 Credits

Waves and Optics

Interference: Superposition principle, coherence of light, methods to produce coherent light: division of amplitude and wave front division, young's double slit experiment: concept, working principle, and applications, Newton's ring: concept, working principle, and applications

Diffraction: Fraunhofer's single-slit diffraction, diffraction grating, and resolving power of a grating.

Polarization: Types of optical polarization, various methods to produce polarized light, working and applications of retarder plates, and half-shade polarimeter: construction and working principle.

Lasers and Optical Communication

LASER: Basic theory of LASER, Einstein's coefficients and their relations, concept of population inversion, components of lasers, modes of laser beam, construction and working principle of various types of lasers: Ruby, Helium-Neon, and semiconductor diode lasers.

Optical Fibre: Optical fibre and its working principle, total internal reflection, numerical aperture, modes of propagation, and classification of optical fibres.

Quantum Physics

Origin of quantum theory and related experiments: Black-Body radiation, photo-electric effect, and Compton effect. Heisenberg's uncertainty principle, de- Broglie's wave concept, phase and group velocities, wave function, and its properties, operators, Schrödinger's time-dependent and time-independent equations, particle in one-dimensional, infinite potential and finite potential wells, and quantum tunnelling phenomena and their applications in alpha decay, and scanning tunnelling microscopy (STM).

Magnetic, Superconducting and Dielectric Materials

Magnetic Materials: Introduction to Weiss theory of ferromagnetism, concepts of magnetic domains, Curie transition, hard and soft magnetic materials and their applications, magneto-resistance, GMR, and TMR.

Superconducting Materials: Introduction to superconductivity, Meissner effect, Type-I and Type-II superconductors and their applications.

Dielectric Materials: Introduction to dielectrics, dielectric constant, polarizability, frequency and temperature dependent polarization mechanism in dielectrics, dielectric loss, and applications.

Advanced Functional Materials & NDT

Smart Materials: Biomaterials, high-temperature materials and smart materials, applications of functional materials.

Nanomaterials: Introduction, classification, and properties of nanomaterials, various methods of synthesizing nanomaterials: top-down (ball milling) and bottom-up (sol-gel) approaches.

Photovoltaic Materials: Solar spectrum, photovoltaic effect, materials, structure and working principle, I-V characteristics, power conversion efficiency, quantum efficiency, emerging PV technologies, and applications.

NDT: Methods of non-destructive testing

Text Books:

1. A Textbook of Engineering Physics, M. N. Avadhanulu, P. G. Kshirsagar, S. Chand and Company (2015).
2. Concepts of Modern Physics, Beiser A., Mc. Graw Hill Publishers (2003).
3. Optics, Ajoy Ghatak, Tata Mc Graw Hill (2012).
4. Materials Science and Engineering: An Introduction (Tenth edition), William D. Callister, John Wiley & Sons (2018).
5. Introduction to Solid State Physics, Charles Kittel, Wiley Publishers (2011).

EC101	Basic Electronics Engineering	ESC	2 – 0 – 0	2 Credits

Detailed Syllabus:

Introduction to electronics systems, diode circuit models and applications, Zener diode as regulator, photodiode.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications. FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive Feedback, Principles of LC and RC oscillators.

Integrated Circuits: Operational amplifiers Characteristics and applications, linear operations using Op-amps.

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Sequential Circuits, Analog to Digital and Digital to Analog converters (ADC/DAC).

Laboratory measuring instruments: principles of digital multi-meters, Cathode ray oscilloscopes (CRO).

Text Books:

1. Bhargava N. N., D C Kulshreshtha and S C Gupta, *Basic Electronics & Linear Circuits*, 2nd Edition, Tata McGraw Hill, 2013.
2. S. Sedra and K. C. Smith, *Microelectronic Circuits*, Oxford University Press , 6th Edition
3. Leach , Malvino, Saha, *Digital Principles and Applications*, McGraw Hill Education , 8th Edition
4. Boylestad, Robert L., Louis Nashelsky, *Electronic Devices and Circuits*, Pearson , 11th Edition
5. Helfrick and Cooper, *Modern Electronic Instrumentation and Measurement Techniques,* PHI, 2011
6. Neil Storey, Electronics A Systems Approach, 4th Edition, Pearson Education Publishing Company Pvt Ltd.

CE102	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	**ESC**	**2-0-0**	**2 Credits**

Detailed Syllabus:

Introduction to Environmental Science: Environment and Societal Problems, Major Environmental Issues, Global Climate Change Agreements, Montreal, Kyoto Protocol & Paris Agreement, Basics of Environmental Impact Assessment, Principles of Sustainability, and related indices, Population Dynamics, Urbanization. Identification and Evaluation of Emerging Environmental Issues with Air, Water, Wastewater and Solid Wastes, Introduction to Environmental Forensics.

Water & Wastewater Treatment: Water Sources, constituents, potable water quality requirements (IS 10500), overview of water treatment, sources and types of pollutants, their effects, self-purification capacity of water bodies, principles of wastewater treatment, 5R Concept.

Air & Noise Pollution: Sources, classification and their effects, national ambient air quality standards (NAAQS), air quality index, dispersion of pollutants, control of air pollution, understanding and improving indoor air quality, sources of noise pollution, effects, quantification of noise pollution.

Solid Waste Management: Sources and characteristics of solid waste, effects, 3R concept, sustainable practices in waste management, CPHEEO guidelines for solid waste management, transition to zero waste lifestyle.

Text Books:

1. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education, 2013.
2. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt Ltd, Special Indian Edition, 2007.
3. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill, New Delhi, 2006.
4. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous (1985), Environmental Engineering, McGraw Hill Inc., New York
5. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill, Eighth Edition, 2016.

CS101	Introduction to Algorithmic Thinking and Programming	SD	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Construct algorithms for solving problems that requires solutions involving searching, sorting, selection and / or a numerical method as a sub-routine.
CO2	Analyze the suitability of different algorithmic design paradigms for solving problems with an understanding of the time and space complexities incurred.
CO3	Construct algorithms for solving problems with an understanding of the internals of a computing system and its components like processor, memory and I/O sub-systems.
CO4	Construct efficient modular programs for implementing algorithms by leveraging suitable control structures.
CO5	Construct efficient programs by selecting and using suitable in-built Data Structures and programming language features available.

Course Articulation Matrix:

CO \ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	S	M	L									
CO2	S	M	L									
CO3	S	M	L		L							
CO4	S	M	L		S							
CO5	S	M	L		S							

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Fundamentals of Computers, Historical perspective, Early computers, Modern Computers, Hardware Components of a Computer, Data Representation in Computers, Introduction to Operating Systems, Software and Firmware, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques – Algorithmic approach, characteristics of algorithms, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms, Algorithm Analysis.

Basic Syntax in Python, Data Types, Variables, Assignments, immutable variables, Types of Operators, Expressions, Comments, Boolean Logic, Logical Operators in Python.

Conditional statements - If-else, Loops - while, for, Lazy Evaluation

Inbuilt Data Structures and their operations in Python: List, Tuples and Dictionaries.

Fundamental Algorithms: Swapping variables, Problems involving summation of a series, Sine function computation, Base Conversion, generation of sequences like Fibonacci, Reversing the digits of an integer, Character to number conversion.

Factoring Methods: Finding the square root, Finding the smallest divisor of an integer, finding the greatest common divisor using Euclid's algorithm, Computing the prime factors of an integer, generating prime numbers, Raising a number to a large power, Computation of the nth Fibonacci number.

Functions – Modular programming and benefits, user defined functions, library functions, parameter passing, Formal and Actual arguments, named arguments return values, Recursion.

Sorting algorithms: Bubble, Selection and Insertion sorts, Search algorithms: Linear and binary search

String processing: Algorithms for implementing String functions like Strlen, Strcpy, StrRev, Strcmp, Searching for a keyword or pattern in a text.

File and Directory Handling: Reading and Writing to/from a file, Formatted File creation and operations.

Simple 2D Graphics, drawing 2D objects using Turtle Graphics.

Text Books:

1. Kenneth Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2019
2. R.G. Dromey, how to solve it by Computer, Pearson, 2008.

CS102	Introduction to Algorithmic Thinking and Programming Lab	SD	0 – 1 – 2	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Construct, debug, test and run efficient programs by leveraging suitable flow of control constructs and syntactic units of the programming language.
CO2	Construct efficient programs by constructing and translating algorithms for solving problems using sorting, searching, selection and / or arithmetic computations.
CO3	Implement, refactor, test and debug functional programs in a shell-based run time environment.
CO4	Construct efficient programs by demonstrating problem-solving skills and out-of-the-box algorithmic thinking.

Course Articulation Matrix:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	S	M	L		S				M			L
CO2	S	M	L		S				M			L
CO3	S	M	L		S				M			L
CO4	S	M	L		S				M			L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

List of Experiments:

1. Familiarization with Python installation, basic syntax and running scripts in the shell.
2. Programs on conditional control constructs.
3. Programs on iterative constructs. (While, do-while, for).
4. Programs using user defined functions and in-built function calls.
5. Programs related to Recursion.
6. Programs involving in-built data structures like List, Tuples and Dictionaries.
7. Programs related to String processing.
8. Programs related to Files and I/O.
9. Implementation of Factoring methods.
10. Programs that require sorting, searching and selection as sub-routines.
11. Problems involving simple 2D graphics.
12. Implementation of a capstone application to unify the concepts learnt in the course.

Reading List:

1. Kenneth Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2019.
2. R.G. Dromey, how to solve it by Computer, Pearson, 2008.
3. The Python Tutorial, Available at: https://docs.python.org/3/tutorial/.

PH102	Engineering Physics Lab	BSC	0-0-2	2 Credits

List of experiments (any eight of the following):

Exposure to virtual lab (any three of the following):

S. No	Name of the experiment
1	Determination of Planck's constant using light emitting diode.
2	Determination of wavelength of monochromatic light in Newton's ring experiment.
3	Determination of the width of narrow slit by diffraction method.
4	Determination of wavelength of He-Ne laser using diffraction by a metal scale.
5	Determination of capacitance and time constant of a capacitor using R-C circuit.
6	Determination of wavelength of mercury spectrum by normal incidence method (diffraction grating).
7	Determination of specific rotation of an optically active material-using Laurent's half-shade polarimeter.
8	Determination of resonating frequency and bandwidth of an LCR circuit.
9	Determination of dielectric constant of various dielectric materials.
10	Studying B-H curve loop and permeability of magnetic materials.
11	Measuring spatial distribution of magnetic field between a pair of identical coils using Helmholtz coils.
12	Studying current-voltage characteristics of a photovoltaic material using solar cell.
13	Determination of numerical aperture of an optical fibre.
14	Determination of resistivities of various materials using four-probe method.

1. LCR – Series/Parallel
2. B-H Loop tracer
3. Planck's Constant
4. Numerical aperture of Optical Fiber
5. Newton's rings

Micro project:

This can be implemented in the subsequent semesters based on the facilities available. In the case of implementation, three or four experiments from the above listed eight experiments will be replaced with the project (~40 % of the experiments will be relaxed).

References:

1. *Physics Laboratory Manual*, School of Sciences (Physics), National Institute of Technology Andhra Pradesh (2020).

2. *Practical Physics (Electricity, Magnetism, and Electronics),* R. K. Shukla, A Srivastava, New age international publishers (2011).

3. *B.Sc. Practical Physics*, C. L. Arora, S. Chand & Co. Ltd. (2012).

EA101	Physical Education	MSC	0-0-3	1 Credit

Detailed Syllabus:

I. Introduction to Physical Education & EAA = Sports and Games

Meaning & Definition of Physical Education, Aims & Objectives of Physical Education, Importance of Physical Education

II. Physical Fitness & Wellness Lifestyle

Meaning & Importance of Physical Fitness, Components of Physical Fitness (Cardiovascular Endurance, Strength Endurance Muscular Endurance, Flexibility, Body Composition), Components of Motor Fitness (Agility, Balance, Power, Speed, Coordination), Development of Fitness Components

III. Training Methods in Physical Education

Circuit Training (Circuit Training), Continues Training (Endurance), Interval Training (Speed & Endurance), Fartlek Training (Speed Endurance), Weight Training (Maximum Strength), Plyometric Training (Power), Flexibility Training

IV. Test & Measurements

Measurements: Height, Weight, Age, Calculation of BMI, Motor Fitness and Physical Fitness Tests (Pre - Test & Post-Test), Cardiovascular Endurance - 9/12 Minute Run or Walk, Muscular Endurance – Sit Ups for abdominal strength, Strength Endurance – Flexed arm hang for girls / Pull ups for boys, (Speed – 50m Dash or 30mts Fly Start, Strength – Broad Jump, Vertical Jump for Lower Body, Medicine Ball Put for Shoulder Strength, Endurance - 800mts, Flexibility - Bend and Reach, Agility (Coordination)) – Shuttle Run and Box Run

V. Formal Activities

Calisthenics (free hand exercises), Dumbbells, Woops, Wands, Laziums (Rhythmic activities), Aerobic Dance and Marching

VI. Sports / Games

Following sub topics related to any one Game/Sport of choice of student out of: Athletics, Badminton, ball badminton, Kabaddi, Kho-Kho, Table Tennis, Yoga etc., Teaching & Coaching of the Game/Sport, Latest General Rules of the Game/Sport.

Specifications of Play Grounds and Related Sports Equipment

EA151	Health Education	MSC	0-0-3	1 Credit

Health Education & Personal Hygiene

Introduction & Meaning of Health Education, Definition of Health Education, Principles of Health Education, Importance of Health Education, Meaning of Personal Hygiene, Importance of Personal Hygiene, Personal cleanliness (teeth, ears, eyes, nose & throat, nails & fingers, skin, cloths, and hair).

Nutrition

Introduction of Nutrition, Balanced Diet, Daily Energy Requirements, Nutrient Balance, Nutritional Intake, Eating and Competition, Ideal Weight

First Aid & Injury Management

Introduction, Types and Principles of First Aid, Functions of First Aider, Reasons for Sports Injuries,The First Aid and Emergency Treatment in Various cases (drowning, dislocation & fractures, burns, electric shock, animal bite, snake bite, poison, etc.

Human Posture

Introduction, Meaning of Posture, types of Good Posture, causes of Poor Posture, preventive and Remedial Poor Posture, common Postural Deformities, Body Types, Advantages of Good Posture

Yoga

Introduction, Meaning & Importance of Yoga, Elements of Yoga, Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas, Yoga for concentration & related Asanas (standing asanas, sitting asanas, supine and prone postures.), Relaxation Techniques for improving concentration – Yoga – nidra, Pranayama

Sports / Games

Following sub topics related to any one Game/Sport of choice of student out of: Athletics, Badminton, ball badminton, Kabaddi, Kho-Kho, Table Tennis, Yoga etc.,Teaching & Coaching of the Game/Sport., Latest General Rules of the Game/Sport, Specifications of Play Grounds and Related Sports Equipment.

ME102	**Engineering Graphics with Computer Aided Drafting**	**ESC**	**2-0-0**	**2 Credits**

Note: 50% of the Practice through manual drawing and 50% of the Practice through a Computer Aided Drafting Package.

Detailed Syllabus:

Introduction: Overview of the course, Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Construction of Polygons, Scales. Introduction to Computer Aided Drafting (CAD), DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES, etc.

Orthographic Projection: Principles, of Orthographic projection, Four Systems of Orthographic Projections.

Projection of Points: Projections of points when they are situated in different quadrants.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces.

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Sections of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric Views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views - simple objects.

Text Books:

1. N.D. Bhatt and V.M. Panchal, Engineering Graphics, Charotar Publishers, 2013.

2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, Dreamtech Press, 23 rd Edition, 2016.

CY101	Engineering Chemistry	BSC	3-0-0	3 Credits

Basic Organic Chemistry

Reaction intermediates: carbocations, carbanions, free radicals and carbenes. Classification of organic reactions, examples and their mechanisms: substitution, addition, elimination and rearrangement reactions. Reimer–Tiemann reaction, Kolbe-Schmidt reaction, Cannizzaro reaction. Pinacol-Pinacolone, Hofmann and Beckmann rearrangements. Diels-Alder reaction.

Spectroscopic Techniques for Chemical Analysis

Introduction of spectroscopy, Quantum aspects of electronic, vibrational and nuclear energy levels. UV-Visible spectroscopy: Principle, Instrumentation, Beer-Lambert's law, Effect of conjugation, Woodward-Fieser empirical rules for acyclic/cyclic dienes. IR spectroscopy: Principle, Factors that affect vibrational frequencies and functional group detection. Proton NMR spectroscopy: Principle, Instrumentation, Chemical equivalency, Chemical shift and spin-spin splitting. Applications of UV-Vis, IR and proton-NMR spectroscopy in determining the structure of small organic molecules.

Coordination Chemistry

Introduction of coordination chemistry, Valence bond (VB) theory and shapes of Inorganic Compounds, Spectrochemical series, Crystal Field theory (CFT): octahedral and tetrahedral complexes, Crystal field splitting energy (CFSE); Molecular Orbital (MO) Theory: Molecular orbital diagrams for octahedral complexes (strong and weak ligand fields).

Electrochemistry

Electrodes, Electrochemical Cells, Electrochemical series and Nernst equation; Conductometry and Potentiometry; Batteries: Types of batteries, Ni-Cd and Lithium (Li)-ion batteries; Fuel Cells: Hydrogen-Oxygen, Methanol-Oxygen fuel cells; Corrosion - Theories of corrosion, Wet corrosion, Types of wet corrosion, Factors affecting the rate of corrosion, Corrosion control methods: Sacrificial anode method and Impressed current method.

Engineering Materials and Applications

Polymers: Introduction, Types of polymerization, Functionality in polymers, Number and Weight average molecular weight, Polydispersity index, Biodegradable polymers; Conductive polymers: classification, examples and applications; Organic light emitting diode (OLED): structure, principle and applications; Optical fibres: principle and Applications.

Reading List:

1. Organic Chemistry, Clayden, Greaves, Warren and Wothers, Oxford University Press, 2014.
2. Organic Spectroscopy, William Kemp, 2nd edition, Macmillan publishers, 2019.
3. Advanced Inorganic Chemistry, F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo and Manfred Bochmann, 6th Edition, 1988.
4. Physical Chemistry, P. Atkins and Julio de Paula, 8th Edition, Freeman & Co. 2017.
5. A Textbook of Engineering Chemistry, Shashi Chawla, 2017.
6. Polymer Science and Technology, Premamoy Ghosh, 3rd edition, McGraw-Hill, 2010.

EE101	Elements of Electrical Engineering	ESC	2-0-0	2 Credits

Detailed Syllabus

Basic Concepts

Electric Charge, Current and Electromotive force, Potential and Potential Difference; Electrical Power and Energy; Ohm's Law, Resistance, Capacitance and Inductance, Series and Parallel Connection of Resistances and Capacitances, Kirchoff's Laws and Their Applications

AC Fundamentals:

Concept of Alternating Voltage and Current, RMS and Average Values, Single Phase and Three Phase Supply; 3-ph Star-Delta connections, Alternating Voltage applied to Pure Resistance, Inductance, Capacitance and their combinations, Concept of Power and Power Factor in AC Circuit.

Measuring Instruments:

Principle and Construction of Instruments used for Measuring Current, Voltage, Power and Energy, Methods and precautions in use of these.

Electromagnetic Induction:

Concept of Magnetic Field, Magnetic Flux, Reluctance, Magneto Motive Force (MMF), Permeability; Self and Mutual Induction, Basic Electromagnetic laws, various losses in magnetic circuits;

Electrical Machines:

Elementary concepts of an electrical machine, Basic principle of a motor and a generator, Classification of Electrical machines; Principles, Construction and Working of a machine; Starters: Need, Construction and Operation; Transformer: Classification, Principles, Construction and Working of a Transformer, Applications of Transformers;

Utilization of Electricity:

Utilization concepts of Electricity for electrolysis process, Electrochemical Cells & Batteries; Application of Electricity, Energy Conversation and Efficiency

Basic Troubleshooting:

Basic Testing and faults diagnosis in electrical systems, various tools and their applications, replacement of different passive components.

Electrical Safety:

Electrical Shock and Precautions against it, Treatment of Electric Shock; Concept of Fuses and Their Classification, Selection and Application; Concept of Earthing.

Text Books:

1. Edward Hughes, Electrical & Electronic Technology, Pearson, 12 th Edition, 2016.
2. Vincent Del Toro, Electrical Engineering Fundamentals, Pearson, 2 nd Edition, 2015.
3. V N Mittle and Arvind Mittal, Basic Electrical Engineering, Tata McGraw Hill, 2nd Edition, 2005.
4. E. Openshaw Taylor, Utilization of Electrical Energy, Orient Longman, 2010.
5. B.L.Theraja , Fundamentals of Electrical Engineering and Electronics volume -I, S Chand & Company 2005.
6. Ashfaq Husain, Fundamentals of Electrical Engineering, Dhanpat Rai & Sons 4 th edition, 2010.
7. H.Partab: Art & Science of Utilization of Electric Energy, Dhanpat Rai & Sons, 1998.
8. Fundamentals of Electrical Circuits by Charles k.Alexander, Mattew N.O.Saidiku, Tata McGraw Hill company.

BT101	BIOLOGY FOR ENGINEERS	ESC	2-0-0	2 Credits

Pre-requisites: None

Detailed Syllabus:

Importance of biology to engineers, Molecules of life: Water and Carbon, Evolution and origin of life, Darwins theory, Diversity of life, Chemical basis of life, Nucleic acids, Amino acids and Proteins, Carbohydrates, Lipids and Membranes.

Cell structure and function:

Prokaryotic, Eukaryotic cell and Virus, Sub cellular organelles and their functions, Regulation of cellular metabolism: Cellular respiration and Fermentation, Photosynthesis, Cell division (differences between mitosis and meiosis), Mendel's Law and Patterns of inheritance.

Gene structure and expression

Difference between prokaryotic and eukaryotic gene structure, DNA replication, Transcription, RNA processing and Translation, Control of gene expression (lac operon).

Applications of Biology in Engineering

Genetic engineering (microbe, plant and animal cells for improvement), Industrial Biotechnology (Primary and Secondary metabolites), Environmental engineering, Biopharmaceuticals, Tissue engineering, Biomaterials, Stem cell engineering, Biosensors, Bioinformatics.

Text books:

1. Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Biological Science, Pearson Education India, 2016.

2. Reinhard Renneberg, Viola Berkling and Vanya Loroch, Biotechnology for Beginners, Academic Press, 2017.

ME101	Basics of Mechanical Engineering	ESC	2-0-0	2 Credits

Detailed Syllabus:

Evolution of Mechanical Engineering: Introduction, Definition and scope of Mechanical Engineering, relation of Mechanical Engineering with other Engineering Disciplines, Revolutionary Inventions in wheels, tools, windmills, steam engine, CNC machines, Rapid Prototyping, Air-conditioning and Refrigeration, History of Mechanics, Thermodynamics and Heat Transfer, Production and Industrial Engineering, Mechatronics.

Engineering Materials: Introduction to Engineering Materials, Classification and Properties, Alloys. Composites, Micro and Nano Materials.

Manufacturing Processes: Castings - Patterns & Moulding, Metal forming, Hot Working and Cold Working Extrusion, Drawing, Rolling, Forging. Welding - Arc Welding & Gas Welding, Soldering, Brazing. Introduction to Machining processes – Lathe, Milling, Shaping, Drilling, Grinding, Introduction to NC/CNC Machines, 3D Printing.

Power Transmission: Transmission of Power, Belt Drives, Gears and Gear Trains -Simple Problems, **Fasteners and Bearings:** Fasteners - Types and Applications, Bearings - Types and Selection,

Thermodynamics: Introduction to Energy Sources - Thermodynamics - System, State, Properties, Thermodynamic Equilibrium, Process & Cycle, Zeroth law of Thermodynamics, Work & Heat, First law - Cyclic process, Change of State, Cp, Cv, Limitations of First law, Thermal Reservoirs, Heat Engine, Heat Pump/Refrigerator, Efficiency/COP, Second law, PMM2, Carnot Cycle, Entropy - T-S and P-V diagrams.

Introduction to Steam Turbines and I.C. Engines: I.C. Engines: 2-Stroke & 4-Stroke Engines, P-v Diagram; S.I. Engine, C.I. Engine, Differences.

Introduction to Heat Transfer and Refrigeration: Vapor Compression Refrigeration Cycle - Refrigerants, Desirable Properties of Refrigerants. Modes of Heat Transfer, Thermal Resistance Concept, Composite Walls & Cylinders, and Overall Heat Transfer Coefficient – problems.

Text Books:

1. Dixit, U.S., Hazarika, M. and Davim, J.P, A Brief History of Mechanical Engineering, Springer, 2017.
2. M.L. Mathur, F.S. Mehta and R.P. Tiwari, R.S. Vaishwnar, Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2008.
3. Praveen Kumar, Basic Mechanical Engineering, Pearson Education, India, 2013.
4. P.N. Gupta, M.P. Poonia, Elements of Mechanical Engineering, Standard Publishers, 2004.
5. C.P. Gupta, Rajendra Prakash, Engineering Heat Transfer, NemChand Brothers, New Delhi, 1994.
6. B.S. Raghuvanshi, Workshop Technology, Vol. 1&2, Dhanpath Rai & Sons, New Delhi, 1989.

CE101	Engineering Mechanics	ESC	2-0-0	2 Credits

Prerequisites: None

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space,

Equilibrium of force system- Degrees of freedom - Equilibrium Equations, Degree of Constraints – Free body diagrams.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems

Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of members.

Friction in rigid bodies- Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Centroid & Moment of Inertia - Centroid and M.I – Arial – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles – Introduction to kinematics- Equations of rectilinear motion, D'Alembert's principle -Simple problems- Introduction to kinetics- Work and Energy.

Text Books:

1. J.L.Meriam, L.G. Kraige, Engineering Mechanics, Statics, John Wiley &Sons,7th Edition, 2012.
2. A.K. Tayal, Engineering Mechanics, Umesh Publications, 14th Edition, 2010.
1. S S Bhavikatti and K G Rajashekarappa, Engineering Mechanics, New Age International Publication, 4th Edition.
2. Dietmar Gross, Werner Hauger, Jorg Schroder, Wolfgang A. Wall, Nimal Rajapakse, Engineering Mechanics 1, Statics, Springer, 2nd Edition, 2013.
3. S. Timoshenko, D.H. Young, Pati Sukumar, J V Rao, Engineering Mechanics, Mc-Graw Hill, 5th Edition.

ME103	Workshop Practice	SD	0-1-2	2 Credits

Detailed Syllabus:

Fitting Shop: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaping operation. Demonstration of the working of CNC and 3D Printing Machines.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, half lap Dovetail joint and Mortise Tenon Joint.

Welding: Study of welding tools and welding equipment, Arc Welding Practice (Lap and Butt joint).

CY102	Engineering Chemistry Lab	BSC	0-0-2	2 Credits

List of experiments (any eight of the following):

Exp. No	Name of the experiment
1	Standardization of $KMnO_4$ solution
2	Determination of Iron in Haematite
3	Determination of Hardness of Water
4	Determination of available chlorine in bleaching powder and of iodine in Iodized salt
5	pH-metric titration of an acid vs a base
6	Conductometric titration of an acid vs a base
7	Potentiometric titration of Fe^{2+} against $K_2Cr_2O_7$
8	Colorimetric determination of Potassium Permanganate
9	Determination of rate of Corrosion of mild steel in acidic environment in the absence of presence of an inhibitor
10	Determination of Chlorophyll in Olive oil by using UV and Fluorescence spectroscopic techniques
11	Functional group analysis of organic compounds by using IR spectroscopic technique
12	Organic solvent evaporation by using rotary-evaporation technique

Virtual labs

1. Determination of unknown concentration of analyte by using the Beer-Lambert's law.
2. Identification of unknown components using spectroscopic techniques.
3. Nuclear magnetic resonance spectroscopy and evolution of simple ^{1}H NMR spectra of organic compounds
4. Study of kinetics of a reaction by using spectrophotometric methods.

Text Books:

1. Charles Corwin, Introductory Chemistry laboratory manual: Concepts and Critical Thinking, Pearson Education, 2012.
2. David Collins, Investigating Chemistry: Laboratory Manual, Freeman & Co., 1st Edition, 2006.

II Year B.Tech. (ECE) Courses offered by ECED

EC201	Network Analysis	ESC	3–1–0	4 Credits

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Solve network problems using mesh current and node voltage equations
CO2	Design resonant circuits for given bandwidth
CO3	Compute responses of first order and second order networks using time domain analysis
CO4	Obtain circuit response using Laplace Transform
CO5	Analyze networks using Thevenin, Norton, Maximum power transfer, Superposition, Miller and Tellegen's theorems

Course Articulation Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	-	-	-	-	-	-	-	-	-	-	-	L	-
CO2	M	S	-	-	-	-	-	-	-	-	-	-	L	-
CO3	M	M	-	-	-	-	-	-	-	-	-	-	L	-
CO4	S	M	-	-	-	-	-	-	-	-	-	-	L	-
CO5	S	M	-	-	-	-	-	-	-	-	-	M	L	L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction

CIRCUIT ELEMENTS AND RELATIONS: Types of Sources and Source Transformations - Dot convention and formation of loop and node equations, NETWORK GRAPHS AND ANALYSIS: Graph of a network, Incidence matrix, Cut set and Tie set matrices - Formation of equilibrium equations - Dual networks. TIME DOMAIN ANALYSIS: Solution of network equations in time domain - classical differential equations approach - Initial conditions and their evaluation - Applications to simple RLC-circuits only.

APPLICATIONS OF LAPLACE TRANSFORMS IN CIRCUIT THEORY: Laplace transforms of Various signals of excitation - Waveform synthesis, Laplace transformed networks Determination and representation of initial conditions - Response for impulse function only and its relation to network admittance - convolution integral and applications.

STEADY STATE ANALYSIS OF CIRCUITS FOR SINUSOIDAL EXCITATIONS: 1-phase series, parallel, series - parallel circuits - Solution of AC networks using mesh and nodal analysis. RESONANCE AND LOCUS DIAGRAMS: Series and parallel resonance - Selectivity - Bandwidth - Q factors – Times circuits. Locus diagrams for RL and RC circuits with AC excitation for parametric and frequency variations under steady state conditions.

NETWORK THEOREMS AND APPLICATIONS: Superposition theorem; Thevenin's and Norton's theorems; substitution and compensation theorems - Reciprocity theorem; Millman's theorem;

Maximum power transfer theorem; Tellegen's theorem - Their applications in analysis of networks.

Text Books:

1. Network Analysis, M.E. Van Valken Burg, 3rdedition, PHI, 2015.
2. A Course in Electrical Circuits Analysis. M.L. Soni and J.C. Gupta, 20th revised Edition, Dhanpat Rai & Co.(P), 2004.
3. Network Analysis. G.K. Mithal and Ravi Mittal, 14th edition, Khanna Khanna Pub, 2016.
4. Engineering Circuit Analysis, William H. Hayt,Jack E. Kemmerly, Steven M. Durbin,. 8th edition, Mc Graw Hill Education, 2015.

EC202	Digital System Design	PCC	3–0–0	3 Credits

Prerequisites: None
Course outcomes: After completion of the course student will be able to:

CO1	Design of combinational and sequential logic circuits and develop HDL models
CO2	Understand characteristics of the TTL/CMOS logic families and realize Boolean equation using CMOS logic
CO3	Understand SRAM/DRAM organization and periphery circuitry, operation of SRAM cell, DRAM cell, DDR2/DDR4 and FPGA/CPLD
CO4	Design digital systems using FSM and develop HDL models
CO5	Implementation of Serial adder, Traffic light controller, Vending machine controller and ALU digital systems

Course Articulation Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S	M	-	-	-	-	-	-	-	-	-	L	-
CO2	M	S	-	-	-	-	-	-	-	-	-	-	L	-
CO3	-	M	-	-	-	-	-	-	-	-	-	-	L	-
CO4	M	M	L	-	-	-	-	-	M	-	-	-	L	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Number systems and Boolean algebra: Introduction to number systems and Boolean algebra; Boolean identities, basic logic functions, standard forms of logic expressions, simplification of logic expressions.

Logic families: Brief overview of Transistor as a switch; Logic gate characteristics – propagation delay, speed, noise margin, fan-out and power dissipation; Standard TTL and static CMOS gates.

Combinational logic: Arithmetic circuits (full adder, serial binary adder, parallel binary adders, ripple-carry adder, carry- look ahead adder), decoders, encoders, multiplexers, de-multiplexers, Introduction to Verilog HDL, HDL description of combinational circuits.

Sequential logic circuits: Latches and Flip Flops (SR, D, JK, T); Shift register; Counters – synchronous, asynchronous; Sequential circuit design examples in Verilog HDL and simulation.

Finite state machines: Basic concepts and design; Moore and Mealy machines examples; State minimization/reduction, state assignment; Sequence detector; Finite state machine design in Verilog HDL;

Memory: Types of memories, ROM and RAM (SRAM cells, DRAM, SDRAM, DDR, SDRAM, DDR2 SDRAM, DDR4 SDRAM), PLA, PAL; CPLD and FPGA.

Design of Digital systems: Elements of Design style, Algorithmic state Machines (ASM), ASM chart notations, designing state machine using ASM charts, Serial to parallel data conversion, Traffic light controller, Vending machine controller and Serial adder, ALU, Barrel shifter.

Text Books:

1. Digital Design, Morris. M. Mano, Michael D. Ciletti, Fourth Edition, Prentice-Hall India. 2008.
2. Fundamentals of Logic Design. Charles. H. Roth, Fifth Edition, Thomson Brooks, 2005.
3. Verilog HDL: A Guide to Digital Design and Synthesis. S. Palnitkar, second edition, Prentice Hall, 2003.
4. Patterson, Computer Organization and Design: The Hardware/Software Interface. John L. Hennessy David A. 4th Edition, Morgan Kaufmann, 2011.
5. The Art of Digital Design: An Introduction to Top - Down Design. Franklin P. Processor, David E. Winkel, 2nd Edition, PTR Prentice Hall, 1987.
6. Fundamentals of digital logic with Verilog design. S. Brown and Z. Vranesic, Third Edition, McGraw-Hill, 2013.
7. Digital Design: Principles and Practices. J.F. Wakerly, Fourth Edition, Prentice Hall, 2005.
8. Verilog HDL Synthesis A Practical Primer. J. Bhasker, Star Galaxy Publication, 1998.

Reference Books:

1. Digital Design. Mohammad A.Karim, Xinghao Chen, CRC press 2008.
2. Fundamentals of digital logic with Verilog design. Brown, Stephen D, Tata McGraw-Hill Education, 2007.

EC203	Signals and Systems	PCC	3–0–0	3 Credits

Prerequisites: None

Course outcomes: After completion of the course student will be able to:

CO1	Classify the signals as Continuous time and Discrete time
CO2	Analyze the spectral characteristics of signals using Fourier analysis.
CO3	Classify systems based on their properties and determine the response of LTI system using convolution.
CO4	Identify system properties based on impulse response and Fourier analysis.
CO5	Apply transform techniques to analyze continuous-time and discrete-time signals and systems.
CO6	Comprehensive understanding of control systems, order of systems & stability Analysis

Course Articulation Matrix:

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	M	-	-	-	-	-	-	-	-	-	-	-	L	-
CO2	S	-	-	-	-	M	-	-	-	-	-	L	L	-
CO3	S	-	-	-	-	-	-	-	-	-	-	-	L	-
CO4	M	S	-	-	-	-	-	-	-	-	-	-	L	-
CO5	M	S	-	-	-	S	-	-	-	-	-	L	L	-
CO6	M	M	-	-	-	M	-	-	-	-	-	L	L	L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

SIGNALS AND SYSTEMS: Continuous Time and Discrete Time signals, Exponential and Sinusoidal Signals, Unit Impulse and Unit Step Functions, Continuous and Discrete Time Systems, basic System Properties.

LINEAR TIME INVARIANT SYSTEMS: Discrete Time LTI Systems, Continuous Time LTI Systems, properties of LTI Systems, causal LTI Systems Described by Difference equations.

FOURIER SERIES REPRESENTATION OF PERIODIC SIGNALS: Response of LTI systems to Complex Exponentials, Fourier series Representation of CT periodic Signals, properties of CT Fourier Series, Fourier Series representation of DT periodic Signals, properties of DFS, Fourier series and LTI Systems, Filtering, Examples of CT filters, Examples of DT filters.

CONTINUOUS TIME FOURIER TRANSFORM: Representation of a periodic Signals by continuous FT, FT of periodic signals, convolution and multiplication property of continuous FT, systems characterized by Linear Constant Coefficient Differential Equations.

TIME AND FREQUENCY CHARACTERIZATION OF SIGNALS AND SYSTEMS: Magnitude and phase representation of FT, Magnitude and phase response of LTI systems, Time domain and Frequency domain aspects of ideal and non-ideal filters.

DISCRETE TIME FOURIER TRANSFORM (DTFT) and DISCRETE FOURIER TRANSFORM (DFT): Properties of DTFT and DFT, convolution property, multiplication property, Duality, Systems characterized by Linear Constant Coefficient Difference Equations.

SAMPLING: Sampling theorem, Impulse sampling, sampling with zero order Hold, Reconstruction of signal from its samples using interpolation, Effect of under sampling.

Z-TRANSFORM: Z-transform, Region of convergence and its properties, Inverse Z transform, properties of ZT, Analysis and characterization of LTI systems using ZT, LTI Systems, System function algebra and block diagram representations.

Text Books:

1. Signals and Systems, Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, Prentice Hall India, 2nd Edition, 2009.
2. Linear Systems and Signals, B.P Lathi, 2nd edition Oxford University, 2008.
3. Fundamentals of Signals and Systems, Micheal J Roberts, Special Indian edition, Tata Mc Graw hill, 2010.
4. Digital Signal Processing: Principles, Algorithms and Applications, Fourth Addition, J. Proakis and D. Manolakis, Pearson,2014.

Reference Books:

1. S.Haykin and Barry Van Veen, Signals and Systems, 2nd Edition Wiley, 2007

EC204	Electronic Devices and Circuits-I	PCC	3–0–0	3 Credits

Prerequisites: EC101-Basic Electronic Engineering

Course Outcomes: After completion of the course student will be able to:

CO1	Study and analyze the behaviour of PN junction diodes.
CO2	Characterize the current flow of a bipolar transistor in CB, CE and CC Configurations
CO3	Bias the transistors and FETs for amplifier applications.
CO4	Realize simple amplifier circuits using BJT and FET.
CO5	Analyse RC circuits for low pass and high pass filtering
CO6	Understand the Negative Resistance behaviour of semiconductor devices

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	S	-	S	-	-	-	-	-	-	-	-	L	-	
CO2	-	S	-	S	S	-	-	-	-	-	-	M	L	-	
CO3	-	S	-	-	-	-	-	-	-	-	-	-	L	-	
CO4	-	-	-	S	-	-	-	-	-	-	-	-	L	L	
CO5	-	M	L	S	-	-	-	-	L	-	-	-	L	-	
CO6	M	M	-	-	-	-	-	-	-	-	-	-	L	-	

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

SEMICONDUCTOR DIODES: Band structure of pn junction, current components, Quantitative theory of pn diode, Volt-ampere characteristics and its temperature dependence, Narrow-base diode, Transition and diffusion capacitance of p-n junction diodes, Breakdown of junctions on reverse bias, Zener and Avalanche breakdowns.

JUNCTION TRANSISTOR: PNP and NPN junction transistors, Characteristics of the current flow across the base regions, Minority and majority carrier profiles, Transistor as a device in CB, CE and CC configurations, and their characteristics, Ebers-Moll Model of BJT.

NEGATIVE RESISTANCE SWITCHING CIRCUITS: Voltage controlled and Current controlled negative resistance circuits, Negative Resistance Characteristics, Tunnel diode and its V-I characteristics, Applications using Tunnel diode and UJT.

TRANSISTOR BIASING: The operating Point, DC & AC load lines, Fixed Bias and problems, Collector Feedback Bias, Emitter Feed Back Bias, Self-Bias and problems, Stabilization, various stabilization circuits, Thermal runaway and thermal stability.

FIELD EFFECT TRANSISTORS: JFET and its characteristics, pinch off voltage and drain saturation current, MOSFET: enhancement, depletion modes, Biasing of FETs.

SMALL SIGNAL LOW FREQUENCY TRANSISTOR AMPLIFIER CIRCUITS: Transistor hybrid model, Analysis of transistor amplifier circuits using 'h' parameters, Conversion formulae for the parameters of the three configurations, Analysis of single stage transistor amplifier circuits, RC coupled amplifier. Effect of bypass and coupling capacitors on the low frequency response of the amplifier, FET amplifier configurations, Low frequency response of amplifier circuits, Analysis of single stage FET amplifier circuits.

WAVE SHAPING CIRCUITS: High pass and low pass circuits, Response to sine, step, pulse, square, and ramp inputs with different time constants, High pass as a differentiator, Low pass as an Integrator, clipping circuits: Diode clippers, transistor clippers and two-level clippers, clamping circuits using diodes.

Text Books:

1. *Integrated Electronics*, Millman and Halkias, 2nd Edition, Tata McGraw Hill, 2010.
2. *Solid State Pulse Circuits,* David A. Bell, 4th Edition, Prentice Hall India, 2009.
3. *Electronic Devices and Circuit Theory*, Robert L Boylested and Louis Nashelsky, 8th Edition, PHI, 2003
4. *Electronic devices and circuits, Discrete and Integrated,* Y.N. Bapat, *3rd Edition,* Tata McGraw Hill, 2011.

Reference Books:

1. *Pulse, Digital and Switching Waveforms*, Millman and Taub,3rd Edition, Tata McGraw Hill Education, 2011.
2. *Electronic Devices and Circuits*, David A Bell, 4th Edition, PHI, 2003

EC205	Electronic Devices and Circuits - I Laboratory	PCC	0–0–3	2 Credits

Prerequisites: EC101-Basic Electronic Engineering

Course Outcomes: After completion of the course student will be able to:

CO1	Plot the characteristics of semiconductor diodes and transistors to understand their behaviour.
CO2	Design, construct, and test amplifier circuits and interpret the results.
CO3	Operate electronic test equipment and hardware/software tools to characterize the behaviour of devices and circuits.
CO4	Design and test the Diode clippers, clampers, and rectifiers

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S	-	-	-	-	-	-	M	-	-	-	L	-
CO2	-	S	-	M	-	-	-	-	M	-	-	-	L	-
CO3	-	S	-	M	-	-	-	-	M	-	-	-	L	L
CO4	-	S	-	M	-	-	-	-	M	-	-	-	L	-

S: Strong correlation, M: Medium correlation, L: Low correlation

List of Experiments:

1. Study of Instruments and components
2. V-I Characteristics of Si and Ge Diodes
3. Zener Diode Characteristics and Zener Diode as Voltage Regulator
4. Clippers and clampers
5. Half Wave and Full Wave Rectifiers
6. BJT Characteristics
7. FET Characteristics
8. BJT Biasing
9. FET Biasing
10. BJT as an Amplifier
11. UJT characteristics
12. Circuit design and PCB prototype Implementation of any electronics circuit for real time applications

EC206	Digital System Design Lab	PCC	0–0–3	2 Credits

Prerequisites: None

Course outcomes: After completion of the course student will be able to:

CO1	Develop data flow, behavioural and structural Verilog models for digital circuits
CO2	Compile and Simulate Verilog models of digital circuits using CAD tool
CO3	Synthesize subsystems/ modules using CAD tool
CO4	Implement digital circuits on FPGA prototype boards

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	M	S	-	-	-	-	-	-	-	-	-	L	L
CO2	-	M	S	-	-	-	-	-	-	-	-	-	L	L
CO3	-	S	M	-	-	-	-	-	-	-	-	-	L	L
CO4	-	S	M	-	-	-	-	-	-	-	-	M	L	L

S: Strong correlation, M: Medium correlation, L: Low correlation

List of Experiments:

1. Develop dataflow Verilog models for
   a) 2-to-4 decoder
   b) 8-to-3 encoder
   c) 4:1 mux
   d) full adder/subtractor
   e) 8-bit parity generator/checker
   f) 8-bit Kogge-stone adder
2. Develop structural Verilog models for
   a) 16:1 mux realization using 4:1 mux
   b) 4-bit ripple carry adder using full adder
   c) 8-bit adder using 4-bit ripple carry adder
   d) 8-bit carry select adder using 4-bit ripple carry adder
   e) 16-bit adder by cascading an 8-bit Kogge-stone adder/Ripple carry adder
   f) 4-bit asynchronous up/down counter
3. Develop behaviour Verilog models for

a) 4-bit carry look-ahead adder
b) 4-bit ripple carry adder
c) Edge triggered T-FF/D-FF
d) 16-bit synchronous up/down counter with asynchronous/synchronous load and clear
e) 16-bit Universal shift register

4. Develop Verilog models for implementation of the following modules using top-down design style
   a) Serial Adder b) 16-bit Modified Booth's multiplier c) 16-bit Vedic multiplier d) 32-bit MIPS Processor.
5. Digital Circuit design and Implementation for any real time applications

MA205	**Complex variables and Special Functions**	**BSC**	**3– 0 – 0**	**3 Credits**

Prerequisites: Differential & Integral Calculus (MA101),
Matrices & Differential Equations (MA151).

Course Outcomes: After completion of the course student will be able to:

CO1	understand the concept of analytic function
CO2	Convert complicated regions to simpler regions using the conformal mapping.
CO3	Use the power series to solve ordinary differential equations.
CO4	Learn and use properties of Bessel and Legendre functions

Mapping of course outcomes with program outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4				`								

<u>Complex function:</u>

Complex function: Limit - Derivative - Analytic functions - Cauchy Riemann equations- Laplace's equation. Mappings: Conformal Mapping - Linear fractional transformation. Complex integration: Line integrals in complex plane - Cauchy’s theorem (simple proof only) - Cauchy’s integral formula. Series Expansions: Taylor's and Laurent's series expansions - zeros and singularities - Residue theorem - Evaluation of real integrals using residue theorem. Schwartz- Christoffel transformation. (27)

<u>Series Solutions and Special Functions:</u>

Classification of singularities of an ordinary differential equation - Series solution - Method of Frobenius - Indicial equation – Illustrations. Legendre equation - Legendre functions - Rodrigue's formula - Recurrence relations - Generating function - Orthogonality of Legendre polynomials - Simple Illustrations. Bessel equation - Bessel function - Generating function - Recurrence relations - Orthogonality of Bessel functions - Simple Illustrations. (15)

Reading:

1. R.V. Churchill, *Complex variables and its applications*, McGraw Hill, 2009.
2. W.W. Bell, *Special Functions for Scientists and Engineers*, Dover Publications, 2004.
3. E. Kreyszig: *Advanced Engineering Mathematics*, John Wiley and Sons, 8th Edition, 2008.
4. B.S. Grewal: Higher Engineering Mathematics, Khanna Publications, 2017.
5. M. R. Spiegel, et al. *Schaum's outline of Complex Variables*. McGraw Hill Professional, 2009.

EC251	Electronic Devices and Circuits- II	PCC	3–0–0	3 Credits

Prerequisites: EC203- Electronic Devices and Circuits- I

Course Outcomes: After the completion of the course the student will be able to:

CO1	Design and analyze multistage amplifiers.
CO2	Apply compensation techniques for stabilizing analog circuits against parameter variations
CO3	Design negative feedback amplifier circuits and oscillators
CO4	Analyze and design solid state power amplifier circuits.
CO5	Analyze and design tuned amplifier circuits.

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	S	M	M	-	-	-	-	-	-	L	L	L	-
CO2	M	M	-	-	-	-	-	-	-	-	-	-	L	-
CO3	M	S	M	M	-	-	-	-	-	-	-	-	L	L
CO4	L	S	M	S	-	-	-	-	-	-	-	-	L	L
CO5	L	S	L	S	-	-	-	-	-	-	-	-	L	L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

MULTISTAGE AMPLIFIERS: Classification of amplifiers, Distortion in amplifiers, Frequency response of an Amplifier, Bode plots, Step response of an amplifier, CE short circuit current gain, High frequency response of a CE stage. Gain bandwidth product, Emitter follower at high frequencies, Analysis of Multistage amplifier, Design of two stage amplifier, Common Source and Common Drain amplifier at high frequencies. Frequency response of cascaded stages, Cascode amplifiers (CE-CB), the effect of coupling and bypass capacitors, Differential amplifiers, Analysis of Differential amplifiers.

FEEDBACK AMPLIFIERS: Classification and representation of amplifiers, Feedback concept, the transfer gain with feedback, General characteristics of negative feedback amplifiers. Impedance in feedback amplifiers. Properties of feedback amplifier topologies, approx. analysis of feedback amplifiers, Method of analysis of a feedback amplifier. The shunt feedback triple, Shunt- series pair, Series shunt pair, series triple, general analysis of multistage feedback amplifiers.

STABILITY AND RESPONSE OF FEEDBACK AMPLIFIER: Effect of feedback on bandwidth, Stability, Test of stability, Compensation, General method of compensation, Frequency response of feedback amplifier double pole transfer function. Phase Margin and gain Margin, three pole transfer function with feedback amplifier response, approximate analysis of a multi pole feedback amplifier.

OSCILLATORS: Sinusoidal oscillators, Barkhausen Criterion, Analysis and design of RC phase shift (FET/ BJT) oscillator, Wien bridge oscillators. Resonant circuit oscillators, General form of oscillator circuit (Hartley & Colpitts), Crystal oscillators.

POWER AMPLIFER: Class A, B, AB, and C power amplifiers, push – pull and complementary symmetry push-pull amplifier. Design of heat sinks, power output, efficiency, crossover distortion and harmonic distortion.

TUNED AMPLIFIER: Design and analysis of single tuned amplifier circuit with a capacitor coupled load, double tuned inter stage design. Stability consideration, Class B and class C tuned power amplifiers.

Text Books:

1. *Integrated Electronics*. J.Millman & Halkias,TMH, 1991.
2. *Micro Electronics.* J.Millman & Arian Grabel,Second Edition TMH,1988.
3. *Electronic circuits*. Md.Gausi,First Edition. John Wiley,2004
4. *Micro Electronic Circuits*. A.S.Sedra & K.C.Smith. Seventh Edition, Oxford press, 2017

EC252	Probability Theory and Stochastic Processes	PCC	3–0–0 3 Credits

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	-	-	-	-	-	-	-	-	-	-	-	L	-
CO2	M	M	-	-	-	-	-	-	-	-	-	M	L	-
CO3	M	S	-	-	-	-	-	-	-	-	-	-	L	L
CO4	S	M	-	-	-	-	-	-	-	-	-	-	L	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Scheme of Instructions, Introduction to Subject, Axioms of Probability, Probability Space, Conditional Probability, Bays Theorem, Repeated Trails, Bernoulli's Trails, Problems, Concept of a Random Variable, Distribution and density functions, Properties of distribution functions, Continuous type random variable, Normal, Exponential, chi-square, Rayleigh, Nakagami-m, uniform distributions, etc. Problems, Bernoulli, Binomial, Poisson distributions, Negative binomial distributions.

Conditional distributions, Total probability and Bayes theorem, Poisson approximation Problems, Random Vectors, Functions of one random variable: Expectation, Variance, Moments, Characteristic functions Problems, One function of two random variable, joint moments, joint characteristic functions, conditional distributions, conditional expected values, Random Process concept, Stationarity and independence.

Distribution and density functions, statistical independence, First-order stationary processes, Second order and wide sense stationary process, Problems, Nth order and strict sense stationary process, Problems.

Time averages and ergodicity, Mean ergodic process, Auto correlation function and its properties, Cross- correlation function and its properties, Covariance functions, discrete time processes and sequences, Power density spectrum and its properties, Problems, Linear systems with random inputs. Random signal response, Auto correlation functions of the response, Cross correlation functions of input and output system, Power density spectrum of the response, Problems.

Text Books:

1. A. Papoulis, and Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes, Fourth Edition, McGraw Hill, 2017.
2. P. Peebles, Probability, Random Variables and Random Signal Principles. 4th Edition McGraw Hill, 2017.
3. G. Grimmett and D. Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University Press, 2001

4. S. L. Miller and D. G. Childers, Probability and Random Processes: With Applications to Signal Processing and Communications, 2nd Edition, Academic Press 2012.
5. A. Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition, Pearson, 2008.

EC253	Digital Signal Processing	PCC	3-0-0	3 Credits

Pre-requisites: Signals and Systems

Course Outcomes: After the completion of the course the student will be able to:

CO1	Find DFT of a given signal through Fast Fourier Transform Techniques
CO2	Design FIR and IIR type digital filters.
CO3	Identify various filter structures and evaluate the finite word length and the coefficient quantization effects
CO4	Understand the concepts of sample rate conversion techniques and its applications
CO5	Compare the key architectural features of DSP Processors.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M	-	-	-	-	-	-	-	-	-	-	M	M	
CO2	-	S	-	-	-	-	-	-	-	-	-	-	M	M	
CO3	L	S	-	-	-	-	-	-	-	-	-	-	M	M	
CO4	M	L	-	-	-	-	-	-	-	-	-	-	M	-	
CO5	-	M	-	-	-	-	-	-	-	-	-	L	M	M	

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Review of signals and Systems:

DISCRETE FOURIER TRANSFORM (DFT): The DFT & its properties; Inverse DFT, Linear filtering methods based on DFT - Use of DFT in linear filtering, filtering of long data sequences, Efficient computation of DFT algorithms - Radix 2 (DIT & DIF), Radix 4, Split radix algorithms. Linear filtering approach to computation of DFT - Goertzel algorithm, Chirp z transform, Quantization effects in the computation of DFT - Direct & FFT method.

DIGITAL FILTERS: Linear phase FIR filter, characteristic response, location of zeros, Design of FIR filter - Windowing, Frequency sampling, Design of IIR filters from Analog filters - Impulse invariance, Bilinear transformation, Matched z-transform. Quantization of filter coefficients - Sensitivity to Quantization of filter coefficients, Quantization of coefficients in FIR filters, round off effects in digital filters - Limit cycle, scaling to prevent overflow.

DIGITAL FILTER STRUCTURES: FIR filters - Direct form, Cascade form, Frequency sampling, Lattice IIR filter - Direct form I, Direct form II cascade form parallel form Lattice & Lattice loader.

MULTIRATE DIGITAL SIGNAL PROCESSING: Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, cascade equivalence, Filter design & Implementation for sampling rate conversion, Applications: Phase Shifters, Digital Filter Banks, Sub band Coding of Speech Signals, Quadrature Mirror Filters, Trans multiplexers, Over Sampling A/D and D/A Conversion.

DSP PROCESSORS: TMS C6xxx, Features, Architecture and Applications. Harvard Architecture, pipelining, Multiplier-Accumulator (MAC) Hardware. Architectures of Fixed- and Floating-point DSP processors. Addressing modes, functional modes. Memory architecture, on-chip peripherals of a DSP processor.

Text Books:

1. Digital Signal Processing - Principles, algorithms & Applications, J.G. PROAKIS and D.G. MANOLAKIS, 4th edition, PHI, 2006.
2. Discrete Time Signal Processing. A.V. Oppenheim and R. W. Schafer, 3rd Edition, PHI, 2010.
3. R. J. Schilling, S. L.Harris, Fundamentals of Digital Signal Processing using Matlab. 2nd edition, Cengage Learning, 2011.

Reference Books:

1. S.K. MITRA, Digital Signal Processing – A computer Based Approach. 4th Edition, MGH, 2011.
2. B. Venkataramani and M. Bhaskar, Digital Signal Processors, Architecture, Programming and Application. 2nd Edition, TMH, 2011.
3. P.P. Vaidyanathan, Multi Rate Systems and Filter Banks. Low Price Edition, Pearson Education, 2006.

EC254	Transmission Lines & EM waves	PCC	3-0-0	3 Credits

Pre-requisites: None

Course outcomes: After completion of the course student will be able to:

CO1	Introduce various types of transmission lines and analyze the lumped circuit model of a transmission line and their characteristics.
CO2	Use the smith chart as a graphical tool to solve impedance matching issues
CO3	Solve Maxwell's equations using vector calculus in three standard coordinate Systems
CO4	Understand the power flow mechanism of plane wave
CO5	Deduce EM wave propagation in free space and in dielectric medium

Course Articulation Matrix:

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	-	-	L	-	-	-	-	-	-	-	-	-	L	-
CO2	M	-	-	-	-	-	-	-	-	-	-	-	L	L
CO3	S	-	-	-	-	-	-	-	-	-	-	L	L	L
CO4	S	-	-	-	-	M	-	-	-	-	-	-	L	-
CO5	M	M	-	-	-	M	-	-	-	-	-	-	L	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Networks and Transmission line:
Image and iterative impedance, characteristic impedance. Types of Transmission lines, Applications of Transmission lines, Equivalent circuit of a pair of Transmission lines, Primary constants, transmission line equations, Secondary constants, Distortion less Transmission lines, Phase & Group velocities, Input impedance of Transmission line, Loading of Lines.

RF lines:
RF lines, Lossless transmission lines, Relation between reflection coefficient, load and characteristic impedance, Relation between reflection coefficient and voltage standing wave ratio, Line of different lengths λ/8, λ/4, λ/2, Losses in Transmission lines, Smith Chart and applications, Impedance matching with single and double stubs.

Static Electric and steady Magnetic field:
Coordinate systems, Coulomb's law, Electric Field Intensity, Electric flux density, Gauss's law, Application of Gauss's law, point form of Gauss's law, potential, Potential gradient, Electric Dipole, Current and Current density, Continuity of current, Boundary conditions Poisson's and

Laplace’s equation. Ampere’s law, curl, Vector magnetic potentials, Magnetic Boundary conditions.
Maxwell's equations: The equation of continuity for time varying fields, Maxwell's equations, Conditions at a boundary surface. Applications of circuit and field theory, Comparison of field and circuit theory, Maxwell’s equations as generalization of circuit equations.

Electromagnetic waves:
Plane waves: Wave equations, Plane waves in materials, skin effect, Poynting vector and the flow of power: Poynting theorem, Polarization of plane waves. Power flow for a plane wave and Power loss in a plane conductor.

Reflection and Transmission of Plane Waves:
Reflection and Transmission at a general dielectric interface, Normal Incidence, Refection and Transmission at conductor on oblique incidence, Oblique Incidence on dielectric Interfaces.

Text Books:

1. J. D. Ryder, *Network lines and Fields*. Second Edition, PHI,2008.
2. W H Hayt, J A Buck,*Engineering Electromagnetics*. Seventh Edition, Mc-Graw Hill,2006.
3. M. N O Sadiku,*Elements of Electromagnetics*. Fourth Edition, Oxford University Press, 2007.
4. W C Johnson,*Transmission Lines and Networks*.First Edition, Mc-Graw Hill, 1950.
5. E C Jordan & K. G. Balmain,*Electromagnetic Waves and Radiating Systems*. Second Edition, PHI,1968.

Reference Books:

1. D. K. Cheng, *Field and Wave Electromagnetics*. Second Edition, Pearson, 2014.
2. J. D. Krauss, D. A. Fleisch, *Electromagnetics with Applications*. Fifth Edition, Mc-Graw Hill, 2010.
3. N. Ida, *Engineering Electromagnetics*. Second Edition, Springer, 2005.

EC255	Electronic Devices and Circuits- II Lab	PCC	0–0–3	2 Credits

Prerequisites: None.

Course Outcomes: After completion of the course student will be able to:

CO1	Synthesize and evaluate single stage and two stage amplifiers
CO2	Realize the given performance using feedback amplifiers
CO3	Design and test Oscillator circuits using BJT and FET.
CO4	Design and test the Power amplifiers and Tuned Amplifiers

Course Articulation Matrix:

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	L	S	-	S	-	-	-	-	M	-	-	L	L	L
CO2	L	S	-	M	-	-	-	-	M	-	-	-	L	L
CO3	L	S	-	M	-	-	-	-	M	-	-	L	L	L
CO4	L	S	-	M	-	-	-	-	M	-	-	L	L	L

S: Strong correlation, M: Medium correlation, L: Low correlation

List of Experiments:

1. Single stage BJT amplifier
2. Two stage BJT amplifier
3. FET amplifier
4. Differential amplifier
5. Voltage series feedback amplifier
6. Voltage shunt feedback amplifier
7. Current series feedback amplifier
8. Current shunt feedback amplifier
9. RC phase shift oscillator
10. Wein bridge oscillator
11. LC/ crystal oscillator
12. Power amplifier
13. Tuned amplifier
14. Circuit design and PCB prototype Implementation of any electronics circuit for real time applications

EC256	Digital Signal Processing laboratory	PCC	0-0-3	2 Credits

Pre-requisites: None
Course Outcomes: After the completion of the course the student will be able to:

CO1	Perform basic arithmetic operations on DSP processor.
CO2	Compute Discrete Fourier Transform (DFT) and FFT of a signal in a DSP processor
CO3	Implement different window filters using DSP Processor, MATLAB, and Python
CO4	Computation of the DCT of a 1-D signal using Python

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO2	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO3	-	M	-	-	-	-	-	-	-	-	-	L	M	M
CO4	-	S	-	-	-	-	-	-	-	-	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

List of Experiments:

1. To perform basic arithmetic operations on DSP processor (TMS320C6748) using CCS
2. To perform linear and circular convolution on DSP processor
3. To compute Discrete Fourier Transform (DFT) of discrete time sequence on DSP processor using CCS
4. To compute Fast Fourier Transform (FFT) of discrete time sequence on DSP processor
5. To design FIR and IIR digital filter on DSP processor using CCS and MATLAB
6. To perform enhancement of image brightness and contrast using CCS on DSP processor
7. Use Python to create, display, and analyze signals in the time-domain
8. Use Python to analyze and display signals in the frequency-domain using the FFT algorithm to model the DTFT as well as for spectral analysis using the DFT
9. Perform convolution and simulate LSI systems and difference equations
10. Plot pole-zero diagrams for LSI systems with rational transforms, use Python to study properties of the z-transform and its relationship to stability
11. Determine and plot the frequency response of LSI systems

12. Design FIR and IIR filters using Python to meet specifications on their frequency response using window design, frequency sampling design, and the bilinear transformation
13. Use Python to apply the above methods to process real data for image and signal processing applications

CS285	Data Structures and Algorithms	ESC	2 – 1 – 2	4 Credits

Pre-requisites:

i. Introduction to Algorithmic Thinking and Programming (CS101)
ii. Introduction to Algorithmic Thinking and Programming Lab (CS102)

Course Outcomes: At the end of this course, students will be able to:

CO1	Construct solutions for problems using linear data structures such as Linked List, Stacks and Queues. (Apply)
CO2	Construct solutions for problems using non-linear Data Structures such as Trees and Graphs. (Apply)
CO3	Implement solutions for problems that requires sorting and searching as a sub-routine. (Apply)
CO4	Analyze, evaluate and choose appropriate data structures and algorithms for a specific application. (Analyze)
CO5	Analyze algorithms with respect to their time and space complexities. (Analyze)

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L		S			S	S	M		
CO2	S	M	L		S			S	S	M		
CO3	S	M	L		S			S	S	M		
CO4	S	M	M	L	S			S	S	M		
CO5	S	M	M	L	S			S	S	M		

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction to Data Structures, Algorithm Analysis and Examples based on Asymptotic Notations, Abstract Data Types (ADTs), Stacks, Queues, Circular Queues and Linked List (Singly Linked, Doubly Linked and Circular).

Trees: Representation of Trees, Binary Trees, Binary Search Trees.

Priority Queues, Binary Heap and applications, Hash Tables and Operations, Collision Resolution: Open Addressing and Chaining.

Graphs: Representation of Graphs, Graph Traversal Techniques, Minimum Cost Spanning Trees: Prim's and Kruskal's Algorithms, Shortest Path Algorithms: Dijkstra's Algorithm and Floyd-Warshall Algorithm.

Sorting Algorithms: Merge Sort, Heap Sort, Quick Sort and Counting Sort.

List of Experiments:

1. Implementation of Stacks and Queues using arrays.
2. Implementation of Stack and Queue based applications.
3. Implementation of Single Linked List, Double Linked List and Circular Linked List.
4. Implementation of Stacks and Queues using Linked List.
5. Implementation of Circular Queues.
6. Implementation of Binary Search Trees with its operations.
7. Implementation of Priority Queues.
8. Implementation of Hashing with open addressing and separate chaining methods.
9. Implementation of Graph Traversal techniques: BFS and DFS.
10. Implementation of Minimum cost spanning tree algorithms.
11. Implementation of Dijkstra and Floyd-Warshall Algorithms.
12. Implement the following sorting algorithms: Merge sort, Heap sort, Quick sort, Counting sort.

Reading List:

1. Data structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education. Ltd., Fourth Edition, 2014.
2. Data structures and algorithms in C++, 4th Edition, Adam Drozdek, Thomson, Cengage, 2012.
3. Data structures and Algorithms in C++, Michael T. Goodrich, R. Tamassia, and Mount, Second Edition, Wiley, 2011.
4. Data Structures: A Pseudocode Approach with C++, Richard F. Gilberg, Behrouz A. Forouzan, Pacific Grove, CA: Brooks/Cole, 2001.

III Year B.Tech. (ECE) Courses offered by ECED

III- Year I –Semester (2021-2022)

S. No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.	EC301	Control Systems	3	0	0	03	PCC
2.	EC302	Analog & Digital Communications	3	0	0	03	PCC
3.	EC303	Linear IC Applications	2	0	2	03	PCC
4.	EC304	Microcontrollers	3	0	1	04	PCC
5.	EC305	Antennas Theory	3	0	0	03	PCC
6.		Open Elective – 1/ Foreign language	3	0	0	03	OPC/SD
7.	MEC301	MOOCS-1	2	0	0	02	MOOC
Total			**19**	**0**	**3**	**21**	

EC301	CONTROL SYSTEMS	OPC	3–0–0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behaviour of systems using standardtest signals
CO3	Analyze linear systems for steady state errors, absolute stability, and relativestability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	L	L	L	M	L	L	M	M	M
CO2	S	S	S	S	S	L	L	L	M	L	L	M	M	M
CO3	S	S	S	S	S	L	L	L	M	L	L	M	M	M
CO4	S	S	S	S	S	L	L	L	M	L	L	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed syllabus:

Introduction: Control system types, feedback and its effects-linearization,Basic Elements in Control System - Mathematical Models of Physical System: Differential Equation- Transfer Functions of Single Input, Single Output and Multi Variable Systems - Simple Electrical Networks, Block Diagram Reduction Techniques - Signal Flow Graphs - Mason’s Gain Formula.

Standard Test Signals -Time Response of First and Second Order System, Time Domain- Specifications - Generalized Error Series - Steady State Error - Static and Dynamic Error Constants.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-HurwitzCriterion, Characteristics Equation - Location of Roots in S Plane for Stability - Root Locus Analysis - Effect of Pole Zero Additions on Root Locus - Nyquist Stability Criterion.

Frequency Response of the System - Correlation between Time and Frequency Response Gain and Phase Margin - Bode Plot - Nyquist Plot (Polar Plot).

Introduction to compensation networks - Lag, Lead and Lag Lead networks - Effect of providing Lag, Lead and Lag-Lead compensation on system performance and design using bode plot - P, PI, PID Controllers design.

Introduction to state variables technique, Analysis of R-L, R-L-C networks.

Text Books:

1. B.C. Kuo, Automatic Control Systems, 10th Edition, McGraw-Hill Education, 2017.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 5th Edition,New Age Pub. Co.2008.
3. Kausuhio Ogata, “Modern Control Engineering”, Prentice Hall of India PVT. Ltd, 5th Edition, 2010.
4. Richard Dorf, “Modern Control Systems”, Pearson Education Ltd, 13th Edition, 2017.

5. M.N. Bandyopadhyay, “Control Engineering, Theory and Practice” PHI, 4th print, 2006.

Reference Books:

1. N.K. Sinha, “Control Systems”, New Age International Private Limited Publishers, 3rd Edition, Reprint 2008.
2. A. Nagoorkani, “Control System”, RBA Publications, 3rd Edition, reprint 2012.

EC302	Analog and Digital Communications	PCC	3-0-0	3 Credits

Pre-requisites: EC202-Signals and Systems

Course Outcomes: After the completion of the course the student will be able to:

CO1	Compare the performance of AM, FM schemes
CO2	Model a Digital Communication System
CO3	Convert Analog signal to Digital Signal
CO4	Compare different digital modulation schemes.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	-	-	M	-	-	-	-	-	-	-	M	-
CO2	-	-	-	-	M	-	-	-	-	-	-	-	M	M
CO3	-	L	-	-	S	-	-	-	-	-	-	-	M	-
CO4	-	L	-	-	S	-	-	-	-	-	-	L	M	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

INTRODUCTION: Introduction to communication system, Communication Channels, Need for modulation, Analog vs Digital, Review of Signals and Systems, Description of Noise.

ANALOG MODULATION TECHNIQUES: Definition, Time domain and frequency domain description - AM, DSB- SC, single tone modulation, power relations in AM waves, Generation of AM waves (square law, Switching), Envelop detector, Coherent detection of DSB-SC Modulated waves, SSB, Demodulation of SSB Waves, Frequency Division Multiplexing, Vestigial side band modulation and demodulation, ANGLE MODULATION : Basic concepts, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave, Comparison of FM and AM, Super heterodyne Receiver. Phase modulation, phase locked-loop (PLL).

PULSE MODULATION TECHNIQUES: Pulse Analog and Pulse Digital Modulation Schemes–Pulse Amplitude Modulation, Pulse width modulation, PPM, TDM, Pulse Code Modulation, Differential PCM systems (DPCM), Delta modulation, adaptive Delta modulation, comparison of PCM and DM systems, noise in PCM and DM systems.

SIGNAL SPACE ANALYSIS: Model of Digital Communication Systems, Geometric representation of signals, Gram-Schmidt Orthogonalization, Constellation diagrams, Baseband representation of signals.

DIGITAL MODULATION TECHNIQUES: Modulation techniques: ASK, FSK, PSK, QPSK, QAM. Raised cosine pulse, power spectra, bandwidth efficiency.

PERFORMANCE OF DIGITAL MODULATION TECHNIQUES: MAP and ML criterion, matched filter receiver, correlation receiver. BER and SER analysis of ASK, FSK, PSK, QPSK, and QAM and their comparison.

Text Books:

1. S. Haykin,"Communication Systems", 5th Edition, John Wiley and Sons, 2009
2. B.P. Lathi, “Modern Digital & Analog Communications Systems”, 5th Edition, Oxford University Press, 2019
3. J. G. Proakis, M. Salehi, "Communication Systems Engineering", 2nd Edition, Prentice Hall, 2002
4. H. Taub, D.L. Schilling, "Principles of Communication Systems", Tata McGraw Hill, 2001

Reference Books:

1. Behrouz A. Forouzan, "Data communication and Networking", 5th Edition, Tata McGraw Hill, 2012
2. Leon W.Couch II., Digital and Analog Communication Systems, 8th Edition, Prentice Hall., 2012.
3. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, 4th Edition, McGraw Hill New York, 2002.

EC303	Linear IC Applications	PCC	2-0-2	3 Credits

Pre-requisites: None

Course Outcomes: After the completion of the course the student will be able to:

CO1	Design op-amp circuits to perform arithmetic operations.
CO2	Analyze and design linear and non-linear applications using op-amps.
CO3	Analyze and design oscillators and filters using functional ICs.
CO4	Choose appropriate A/D and D/A converters for signal processing applications.

Course Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S	M	-	-	-	-	-	-	-	-	-	M	M
CO2	M	S	M	-	-	-	-	-	-	-	-	-	M	M
CO3	L	M	M	-	-	-	-	-	-	-	-	-	M	M
CO4	L	M	-	-	M	-	-	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

INTRODUCTION TO OP-AMPS: Ideal Characteristics of op-amp, Pin configuration of 741 op-amp. Op-amp parameters and their measurement. Exercise problems.

LINEAR AND NON-LINEAR APPLICATIONS OF OP-AMPS: Inverting and non-inverting amplifiers and their analysis, Applications: inverting and non- inverting summers, difference amplifier, differentiator and integrator, Voltage to current converter, Exercise problems. Instrumentation amplifier, Log and antilog amplifiers. Precision rectifier, Non-linear function generator, solving differential equations using analog computing blocks. Analog IC Multipliers and applications Comparators, regenerative comparators, input - output Characteristics, Astable and Monostable multi vibrator, Triangular wave- generators, RC-phase shift oscillator, Wein's bridge oscillator.

ACTIVE FILTERS: Low pass, High pass, Band pass and Band Reject filters, Butterworth, Chebychev filters, Different first and second order filter Topologies, Frequency Transformation.

TIMERS & PHASE LOCKED LOOPS: 555 Timer functional diagram, monostable and astable operation, applications. PLL- basic block diagram and operation, capture range and lock range; applications of PLL IC 565, AM detection, FM detection and FSK demodulation. VCO IC 566.

IC VOLTAGE REGULATORS: Series op amp regulator, three terminal IC voltage regulator exercise problems. IC 723 general purpose regulator, Switching Regulator.

DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS: Weighted resistor DAC, R-2R and inverted R-2R DAC. IC DAC-08. Counter type ADC, successive approximation ADC, Flash ADC, dual slope ADC, 1-bit converters, sigma-Delta ADC. DAC and ADC Specifications, Specifications of AD 574 (12-bit ADC).

Text Books:

1. G B Clayton, Operational Amplifiers, 5th Edition, Elsevier science, 2003
2. Ramakant A.Gayakward, Op-Amps and Linear Integrated Circuits, 4th Edition, PHI, 2010
3. Roy Choudary D. and Shail B. Jain, Linear Integrated circuits, 4th Edition, New AgeInternational Publishers, 2010
4. Sergio Franco, Design with Operational Amplifier and Analog Integrated Circuits, 4th Edition,McGraw-Hill Series, 2015.

List of Experiments:

1: Study and Operation of IC testers, pulse generator and digital trainer.

2: Study of logic gate ICs and their applications

3: Frequency response of inverting and non-inverting amplifier.

4: Measurement of Op-amp parameters: (i) Offset voltage (ii) Offset current (iii) CMRR and (iv) Slew rate

5: Characteristics of TTL NAND gate: (i) Sourcing (ii) Sinking (iii) Transfer

6: Verify the functionality of Mux and Decoder ICs and their application.

7: Op-amp monostable and astable multivibrators.

8: Design 2's complement adder/subtractor using IC74283 and verify experimentally.

9: Verify the functionality of Flip-Flop ICs and its application.

10: Mod-N counter using 7490 and 74190.

11: 555 timer: Monostable and astable multivibrators.

12: Mod-N counter using 7492 and 74192.

13: Shift register IC 7495.

14: Low voltage regulator IC 723.

EC304	Microcontrollers	PCC	3-0-1	4 Credits

Pre-requisites: EC201-Digital system design-I

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the evolution of microprocessors and microcontrollers and its architectures
CO2	Understand the evolution and architectures of ARM processors.
CO3	Analyze and understand the instruction set and development tools of ARM
CO4	Understand the architectural features of ARM cortex M4 microcontrollers.
CO5	Understand the exception, interrupts and interrupt handling schemes
CO6	Understand the hardware and interfacing peripheral devices to ARM cortex M4

Course Articulation Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S	-	S	-	-	-	-	-	-	-	-	M	-
CO2	-	S	-	S	-	-	-	-	L	-	-	-	M	-
CO3	-	S	-	-	-	-	-	-	L	-	-	-	M	-
CO4	-	M	-	S	-	-	-	-	L	-	-	-	M	-
CO5	-	M	-	S	-	-	-	-	L	-	-	-	M	-
CO6	M	M	-	-	-	-	-	-	-	-	-	-	M	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction to Microprocessors and Microcontrollers:

Evolution and introduction of 80X86 microprocessor, Architecture of 8086, Memory organization, 8086 system connections and timing. Overview of 8051 microcontroller, Architecture, Instruction set and addressing modes, programming of I/O Ports, Interrupts, timer/ counter and serial communication.

Introduction to ARM Processors: Introduction to ARM processors, Evolution of ARM processors, pipeline organization, ARM Processor cores and CPU cores. Introduction to ARM Cortex-M Processors, ARM Cortex-M4 processor's architecture, Programmer's model, Special registers, Operation Modes.

ARM Cortex-M4 programming: Assembly basics, Instruction set, Data transfer, Data processing, conditional and branch instructions, barrier and saturation operations, Cortex-M4-specific instructions, Thumb 2 instructions, Getting started with µVision, Keil Microcontroller Development Kit for ARM, Typical program compilation flow.

ARM cortex-M4 Memory Systems and interrupts: Overview of memory system features, Memory map, Memory access attributes and permissions, Data alignment and unaligned data accesssupport, Bit-band operations, Overview of exceptions and interrupts, Exception types, Overview of interrupt management, Definitions of priority, Vector table and vector table relocation, Software interrupts, Exception Handling.

Practical:

1. Introduction to Keil- uvision and Keil MDK for ARM.
2. Introduction to STM32CubeIDE.
3. Write a simple program for arithmetic operations – addition, subtraction, multiplication and division of 16 or 32 – bit numbers using ARM Cortex-M4
4. Flashing of LEDS on 8051 and ARM Trainer kit
5. Interfacing ADC on 8051 and ARM Trainer kit
6. Interfacing DAC on 8051 and ARM Trainer kit
7. Interfacing 7-Segment LED on 8051 and ARM Trainer kit
8. Interfacing of Analog Keypad on 8051 and ARM Trainer kit
9. Interrupt using on board push button on 8051 and ARM Trainer kit
10. Interfacing stepper motor with 8051 microcontroller and ARM Cortex-M4 processor
11. Interfacing temperature sensor with 8051 microcontroller and ARM Cortex-M4 processor
12. Interfacing Bluetooth module with 8051 microcontroller and ARM Cortex-M4 processor
13. Interfacing Real Time Clock with 8051 microcontroller and ARM Cortex-M4 processor
14. Interfacing Wi-Fi Module with 8051 microcontroller and ARM Cortex-M4 processor.

Text Books:

1. Manish K Patel, "The 8051 Microcontroller Based Embedded system", TMH, 1st Edition, 2014
2. M.A. Mazidi, J.G. Mazidi, R.D. Mckinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Second Edition. 2013.
3. D. V. Hall. Microprocessors and Interfacing, TMH. Second Edition, 2006.
4. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors,Newnes Publications; Third Edition, 2014.
5. Ata Elahi-Trever Arjeski, "ARM Assembly language with hardware experiment", Springer Int. Publishing, 2015.

Reference Books:

1. Steve Furber , "ARM system on chip Architecture", Pearson Publications, Second Edition. 2000
2. William hohl and Christoper Hinds, "ARM assembly language fundamentals and Techniques" CRC, Second Edition, 2015.

EC 305	Antenna Theory	PCC	3–0–0	3 Credits

Prerequisites: EC254 Transmission Lines and Electromagnetic Waves

Course Outcomes: After completion of the course student will be able to:

CO1	Provide an understanding of antenna radiating principle
CO2	Discuss the fundamental characteristics and parameters of antennas.
CO3	Develop the performance characteristics of antennas arrays, its operating principles, methods and concepts to design
CO4	Develop the performance characteristics of broad band antennas and aperture antennas
CO5	Understand the working principle and design of printed antennas

Mapping of course outcomes with program outcomes:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	M	M	-	-	-	-	-	-	-	-	-	-	M	-
CO2	S	-	-	-	-	-	M	-	-	-	-	-	M	-
CO3	-	M	-	-	-	L	L	-	-	-	-	-	M	M
CO4	-	-	M	-	-	L	-	-	-	-	-	-	M	M
CO5	S	L	L	L	L	-	-	-	-	-	-	-	M	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Fundamentals of Radiation: Introduction to antennas & its significance, Scalar electric potential, vector magnetic potential, radiation from an alternating current element, Induction field, radiation field, power radiated by a current element, Definition of electric dipole, radiation by a half wave dipole. Power by a half wave dipole & its radiation resistance, Radiation from a quarter wave monopole Power radiation and radiation resistance of dipole & monopole (approximate analysis).

Antenna Parameters: Radiation pattern, power pattern, field pattern Radiation intensity, Antenna impedance, mutual impedance, gain and directivity, bandwidth, Polarization, efficiency, effective length, area or aperture, scattering loss, collecting aperture, physical aperture---relation between large aperture and gain Effective aperture of a small elementary dipole, half wave antenna, effective length, front to back ratio, Antenna beam width and side lobes. Friss Transmission formula, Radar range equation.

Design of Arrays: N-element linear array- broadside array, End fire array, multiplication of patterns Effect of earth on vertical pattern mutual impedance effects, binomial and Dolph-Chebyshev arrays.

Broadband Antennas and Aperture Antennas: Log-periodic and Yagi antennas, frequency independent antennas, broadcast antennas, Huygens' principle, radiation from apertures in an infinite ground plane, slot and horn antennas, parabolic reflector antennas

Printed Antennas: Radiation from rectangular and circular patches, feeding techniques.

Text Books:

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007
2. David K. Cheng, —Field and Wave Electromagnetics, Pearson, 2e, 2014.
3. R.E. Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.

Reference Books:

1. Antenna Theory: Analysis and Design – Constantine A. Balanis, John Wiley & Sons, 4^{th} Ed.,2016.
2. John D. Kraus, Antennas, 2nd Edition, McGraw Hill, 1988.
3. David M. Pozar, —Microwave Engineering, Wiley, 4e, 2012.

III- Year II –Semester (2021-2022)

S. No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.	EC351	CMOS VLSI Design	3	0	0	03	PCC
2.	EC352	Embedded and Real Time Operating Systems	3	0	0	03	PCC
3.	EC353	Information Theory & Coding	3	0	0	03	PCC
4.		Department Elective-1	3	0	0	03	DEC
5.		Department Elective-2	3	0	0	03	DEC
6.	EC354	Communication Systems Lab	0	1	2	02	PCC
7.		Open Elective – 2/ Foreign language elective	3	0	0	03	OPC/SD
8.	EC399	Mini Project	0	0	6	03	SD
Total			**18**	**1**	**8**	**23**	

EC351	CMOS VLSI Design	PCC	3-0-0	3 Credit

Course Outcomes: After the completion of the course the student will be able to:

CO1	Explain the fabrication, operation and characteristics MOSFET
CO2	Analyse the performance of CMOS inverter
CO3	Design Digital circuits using CMOS gates
CO4	Design Analog circuits using CMOS gates
CO5	Outline the latest trends in CMOS technology

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	L	M	-	-	-	-	-	-	-	-	-	M	-
CO2	S	M	S	-	-	-	-	-	-	-	-	-	M	M
CO3	S	S	S	-	-	-	-	-	-	-	-	-	M	M
CO4	S	S	S	-	-	-	-	S	-	-	-	-	M	M
CO5	L	M	-	-	-	-	S	-	-	-	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

INTRODUCTION to MOSFETs: Unit process steps of CMOS technology, Fabrication process flow: NMOS, PMOS, Twin well CMOS; Structure and operation of the MOS transistor, I-V and C-V characteristics, MOSFET capacitances, layout, design rules, Body effect, Channel Length Modulation, Scaling and Short channel effects.

MOS INVERTERS: Inverters with resistive, MOSFET load; CMOS inverter: Voltage transfer characteristics, Noise margins, switching characteristics, calculation of delay times; effect of load on switching characteristics and driving large loads, logical effort of paths, power dissipation issues.

Digital circuits using CMOS: Pseudo NMOS, Pass transistor, transmission gates, Dynamic logic, Domino logic, Differential cascade voltage switch logic, design of combinational circuits, design of sequential circuits, timing requirements, Schmitt trigger circuit.

Analog circuits: Second order effects in MOSFETs. Single stage Amplifiers: Common-source stage, Source follower, Common-gate, Cascode stage, Differential Amplifiers, Passive and Active current mirrors, CMOS operational amplifier, gain boosting techniques.

Trends in CMOS technology: SOI, GAAFET, FinFET and multi-gate FET, 2D materials-based FETs, On-chip interconnects.

Text Books:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th Edition, Pearson Education, 2015.

5. P. P. Sahu, “VLSI Design”, McGraw Hill Publication. 2013.

EC352	Embedded and Real Time Operating Systems	PCC	3-0-0	3 Credits

Prerequisites: Microcontrollers

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the applications, Design metrics and challenges of Embedded system
CO2	Design, implement and test an embedded system.
CO3	Write the programs for Arduino based embedded system.
CO4	Describe the various components and operating systems used in real-time embedded systems.
CO5	Building application programs using Keil CMSIS RTOS RTX5

Course Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	M	-	-	-	-	-	-	-	-	M	-	2	2
CO2	M	S	-	M	-	-	-	-	-	-	M	-	2	2
CO3	M	S	-	M	-	-	-	-	-	-	M	-	2	2
CO4	-	M	-	M	-	-	-	-	-	-	M	-	2	-
CO5	-	M	-	-	-	-	-	-	-	-	M	-	2	2

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction to Embedded Systems: Embedded systems Overview, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major ApplicationAreas, Purpose of Embedded Systems, Characteristics of embedded computing applications, Design Challenges, Common Design Metrics.

Embedded System Development: Core of the Embedded System: General Purpose andDomain Specific Processors, ASICs, PLDs, Commercial Off the Shelf Components (COTS). Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer Communication Interface: Onboard and External Communication Interfaces. Embedded system Program: Introduction to Arduino single board microcontrollers, Fundamentals of Arduino Programming, Interfacing of sensors with Arduino Uno, Arduino based Robotics Project.

Real-Time Operating Systems: Architecture of the kernel, Tasks and Task Scheduler, Scheduling algorithms, Interrupt Service Routines, Semaphores, Mutex, Mailboxes, Message queues, Event Registers, Pipes, Signals, Timers, Memory management, Priority Inversion problem.

Keil CMSIS RTOS RTX5: Introduction to Keil MDK-ARM, Introduction to Keil CMSIS RTOS RTX5, Creating an RTX5 project using STM32F103 device, writing program to implement basic RTOS kernel objects in RTX5 using STM32F103 device in Keil MDK.

Text Books:

1. K.V Shibu, “Introduction to Embedded Systems”, Mc Graw Hill India, second edition, 2016
2. Embedded Systems Design –Santanu Chattopadhyay, PHI, 2013.

3. Embedded System Design -Frank Vahid, Tony Givargis, John Wiley
4. Tianhong Pan and YI Zhu, “Designing Enbedded System with Arduino: A Fundamental Technology for Makers”, Springer, 2017.
5. Embedded/Real-Time Systems: Concepts Design and Programming, K.V.K.K. Prasad Dreamtech, 2005
6. Lyla B Das, “Embedded Systems: An Integrated Approach”, Pearson, 2013
7. An Embedded Software Primer -David E. Simon, CD-Rom Edition, Addison Wesley, 2000.

EC353	Information Theory & Coding	PCC	3-0-0	3 Credits

Pre-requisites: EC302-Analog and Digital communication

Course Outcomes: After the completion of the course the student will be able to:

CO1	Acquire knowledge about information and entropy.
CO2	Analyze source-coding and channel-coding techniques
CO3	Specify specific error detecting and error correcting codes in a precise mathematical manner.
CO4	Develop and execute encoding and decoding algorithms associated with the major classes of error detecting and error correcting codes.

Course Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	-	M	-	L	-	-	-	-	-	M	-
CO2	M	S	-	-	L	M	L	-	-	-	-	-	M	L
CO3	M	L	-	-	L	-	L	-	-	-	-	-	M	L
CO4	M	S	-	-	-	L	-	-	-	-	-	-	M	L

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

INFORMATION THEORY: Uncertainty, Information & Entropy, Source coding theorem, The kraft inequality, Huffman coding, Shannon-Fano coding, variable-length coding, Discrete memory-less channels, Channel representation, channel matrix, Types of channels- lossless, deterministic, noise less, binary symmetric channel.

CHANNEL CAPACITY: Mutual information, Channel capacity, Shannon Hartley law, channel coding theorem, differential entropy, mutual information for continuous ensembles, channel capacity theorem. **LINEAR BLOCK CODES:** Introduction to error correcting codes, basic definitions, A Prelude, Galois Field- addition and multiplication tables, Matrix Description of Linear block Codes, Equivalent codes, The Parity Check Matrix, decoding of linear block codes, syndrome decoding, The Standard Array, Error probability after coding, Perfect codes, Hamming codes.

CYCLIC CODES: Introduction to Cyclic codes, Polynomials, Algebraic description of Cyclic codes, The Division algorithm for polynomials, a method for generating cyclic codes, Matrix description of cyclic codes, Systematic and non-systematic encoding and parity check matrix, Systematic Encoding using generator polynomial and parity check polynomial, Syndrome Decoding.

CONVOLUTIONAL CODES: Introduction to Convolutional codes, Tree codes and Trellis codes, Polynomial description of Convolutional codes (analytical representation), Distance notions for Convolutional codes, Matrix description of Convolutional codes, Viterbi decoding.

Text Books:

1. S. Haykin, Digital Communications, John Wiley & Sons, 2009.
2. John G.Proakis, Digital Communications, 5th edition, McGraw Hill, 2007.
3. Shulin/ Daniel J.Costello Jr., Error Control Coding, Prentice Hall series in computer applications in electrical engineering series (2/e) 2005.
4. B.P. Lathi, “Modern Digital & Analog Communications Systems”, 5th Edition, Oxford University Press, 2018.
5. R Bose, “Information Theory, Coding and Cryptography”, 3rd Edition, Mc Graw Hill India 2016.
6. Todd K. Moon, Error Correction coding, John Wiley, 2005.

7. S Gravano, “Introduction to Error Control Codes”, Oxford University Press 2007
8. Amitabha Bhattacharya, “Digital Communication”, TMH 2006
9. Fred Halsall, “Multidedia Communications: Applications, Networks, Protocols and Standards”, Perason Education Asia, 2002.

Department Elective 1

EC361	Data Networks	PCC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: After the completion of the course the student will be able to:

CO1	Identify and explain the fundamental concepts of network architecture, protocols and internetworking principles.
CO2	Design a data communication link considering fundamental concepts of stop & wait, go back-n and selective repeat link layer concepts, CRC and framing.
CO3	Understand the concepts of Wide Area Networks, such as switching, routing, congestion, and QoS.
CO4	Design and build Local Area Networks considering the shared medium choices for highspeed LANs or Wireless LANs
CO5	Understand Internet and Transport Protocols and gain knowledge on Internetwork operations.
CO6	Understand the important aspects of internet applications.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	M	-	-	-	M	-	-	-	-	-	-	M	-
CO2	-	M	-	-	-	M	-	-	-	-	-	-	M	M
CO3	-	S	-	-	-	M	-	-	-	-	-	-	M	-
CO4	-	M	-	-	-	-	-	-	-	-	-	-	M	M
CO5	-	-	-	-	-	-	-	-	-	-	-	L	M	-
CO6	-	-	-	L	-	-	-	-	-	-	-	-	M	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction: Basics of Data Communications for networking; Packet switching, Store-&-Forward operation; Layered network architecture, Overview of TCP/IP operation.

Data Link Layer: Framing; error control, error detection, parity checks, Internet Checksum and Cyclic Redundancy Codes for error detection; Flow control, ARQ strategies and their performance analysis using different distributions; HDLC protocol. Media Access Control (MAC): MAC for wired and wireless Local Area Networks (LAN), Pure and Slotted ALOHA, CSMA, CSMA/CD, IEEE 802.3; ETHERNET, Fast ETHERNET, Gigabit ETHERNET; IEEE 802.11 WiFi MAC protocol, CSMA/CA; IEEE 802.16 WiMAX.

Network Layer: Routing algorithms, Link State and Distance Vector routing; Internet routing, RIP, OSPF, BGP; IPv4 protocol, packet format, addressing, subnetting, CIDR, ARP, RARP, fragmentation and reassembly, ICMP; DHCP, NAT and Mobile IP; IPv6 summary.
Fundamentals of Queuing Theory: Simple queuing models, M/M/- Queues, M/G/1/ Queues, queues with blocking, priority queues, vacation systems, discrete time queues. **Transport Layer:** UDP, segment structure and operation; TCP, segment structure and operation. Reliable stream service, congestion control and connection management.

Network Security and Internet Applications: Security Requirements and Attacks, Confidentiality with Conventional Encryption, Message Authentication and Hash Functions, Public-Key Encryption and Digital

Signatures, Secure Socket Layer and Transport Layer Security, IPv4 and IPv6 Security, Wi-Fi Protected Access. **Selected Application Layer Protocols:** Web and HTTP, electronic mail (SMTP), file transfer protocol (FTP), Domain Name Service (DNS). Real-Time Traffic, Voice Over IP and Multimedia.

Text Books:

1. D. Bertsekas and R. Gallagar, Data Networks, 2/e, PHI, 1992.
2. J.F. Kurose and K. W. Ross: Computer Networking, A Top-Down Approach, 8/e, Pearson, 2021.
3. BEHROUZ A. FOROUZAN, Data Communications and Networking, 5th Edition, McGraw-Hill Education, 2012.
4. DOUGLAS E COMER, Computer Networks and Internet, 6th Edition, Pearson Education Asia, 2015.

Reference Books:

1. A. Leon-Garcia and I. Widjaja: Communication Networks; 2/e, McGraw Hill, 2004.
2. A. S. Tanenbaum, Computer Networks, 5/e, Prentice Hall, 2011.
3. W. Stallings, Data and Computer Communication, 10/e, Pearson Education, 2014.

EC362	OPTIMIZATION TECHNIQUES	DEC	3–0–0	3 Credits

Course Outcomes: At the end of the course, the student will be able to:

CO1	Able to formulate mathematical models of real-world problems
CO2	Understand the major limitations and capabilities of deterministic operations
CO3	Handle, Solve and analyze problems using linear programming and other mathematical programming algorithms
CO4	Solve various multivariable optimization problem

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**S**	-	-	-	-	-	-	-	-	-	-	**M**	**M**	**M**
CO2	**S**	-	-	-	-	-	-	-	-	-	-	-	**M**	**M**
CO3	**S**	-	-	-	-	-	-	-	-	-	-	-	**M**	**M**
CO4	**S**	-	-	-	-	-	-	-	-	-	-	-	**M**	**M**

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction: Statement of an optimization problem, Classification of optimization problems, Overview of various optimization Techniques.

Linear Programming: Definition, Fundamental theorem of linear programming, The simplex algorithm, duality, Primal-Dual method

Unconstrained optimization: Definitions and existence conditions, General properties of minimization algorithms, Line search, The Steepest-Descent Optimization Technique, Newton's method, The Least-p^{th} Optimization Technique- Least square Algorithm. Convex functions, optimality conditions for convex optimization problems

Constrained optimization: Active Constraints versus Inactive constraints, Transformations, penalty functions, Karush-Kuhn Tucker conditions, sufficiency of KKT conditions for convex optimization problems.

Advanced Techniques for Optimization:

Genetic algorithm (GA): Fundamentals of Genetic algorithm, History, Basic concepts, working principle, Applications of GA for standard Bench mark test functions.

Swarm intelligence: Main inspiration source, early variants of PSO, Basic particle swarm optimization, Initialization techniques, Theoretical investigations and parameter selection, Design of PSO algorithm using computational statistics, Termination conditions. Application of PSO, Standard test function optimization.

Text Books:

1. Richard W Daniels, An Introduction to Numerical Methods and Optimization Techniques, Elsevier North Holland Inc,
2. Milani Mitchel, An introduction to Genetic algorithms, 5th Edition, The MIT Press, 1999.
3. AE Eiben and J.E Smith, Introduction to Evolutionary Computing, 2nd Edition, Springer 2015.
4. S Rajasekharan, G.A Vijaya Lakshmi Pai, Neural Networks, Fuzzy logic, and Genetic algorithms, Synthesis and Applications, Prentice hall of India, 2007

5. Weifan Wang, Xuding Zhu, Ding-Zhu Du, Combinatorial Optimization and Applications:5th International Conference, Springer Publications, 2011
6. Stephen Boyd, L Vandenberghe, Convex optimization, Cambridge university press.

EC363	IoT and Applications	DEC	3–0–0	3 Credits

Course Outcomes: After completion of the course student will be able to:

CO1	Understand IOT design requirements
CO2	Compare various technologies and protocols
CO3	Study storage and intelligent analytics
CO4	Application of IOT in smart cities
CO5	Design and experiment various use cases

Mapping of course outcomes with program outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	-	-	-	-	-	-	-	-	-	-	-	M	M
CO2	-	S	-	-	-	-	-	-	-	-	-	-	M	M
CO3	-	-	-	-	-	-	-	S	-	-	-	-	M	M
CO4	-	-	-	-	-	-	-	S	-	-	-	-	M	M
CO5	-	-	-	-	-	-	S	-	-	-	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction to IoT: Elements of an IoT ecosystem, Technology drivers, Trends and implications, Architecture of IoT, Privacy and Security Issues.

IoT Protocols: Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards –Protocols -IEEE802.15.4– BACnet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer– Security.

The Web of Things: Web of Things versus Internet of Things, Linked data, Enterprise data, Importance of security, privacy, and authenticity, Industry standards, Web of Things layer as the driver for IoT systems. Technologies: Wireless protocols, Connectivity options.

Data storage and analysis: Managing high-rate sensor data, Processing data streams, Data consistency in an intermittently connected or disconnected environment, Identifying outliers and anomalies.

Smart Cities: Collection of information including opportunistic sensing, crowd sensing, and Adhoc sensing Response of the system including analytics and optimization, distributed action, people as intelligent actuators, the risk for cyber-attacks in centralized and distributed systems.

Text Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.
2. Designing the Internet of Things, by Adrian McEwen, Hakim Cassimally Wiley 2013.

3. Enterprise IoT Naveen Balani Create Space Independent Publishing Platform 2016.

EC364	Computer Architectures	DEC	3-0-0	3 Credits

Pre-requisites: None.

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the basic structure and operations of digital computer
CO2	Design arithmetic and logic unit
CO3	Evaluate performance of memory systems
CO4	Design and analyze pipelined control units
CO5	Understand parallel processing architectures.
CO6	Familiarize various ways of Communicating with I/O devises and standard interfaces

Course Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	M	L	L	M	M	M	L	-	-	-	M	-
CO2	S	L	L	L	L	L	M	L	L	-	-	-	M	M
CO3	S	M	S	M	S	M	M	M	L	-	-	-	M	M
CO4	S	M	S	L	M	L	M	M	L	-	-	-	M	M
CO5	S	M	M	-	L	L	M	L	M	-	-	-	M	M
CO6	M	M	S	-	S	M	M	M	L	-	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

OVERVIEW & INSTRUCTIONS: Eight ideas – Components of a computer system – Technology – Performance – Power wall – Uniprocessors to multiprocessors; Instructions – operations and operands – representing instructions – Logical operations – control operations – Addressing and addressing modes.

ARITHMETIC OPERATIONS: ALU - Addition and subtraction – Multiplication – Division – FloatingPoint operations – Sub word parallelism.

PROCESSOR AND CONTROL UNIT: Basic MIPS implementation – Building data path – Control Implementation scheme – Pipelining –Pipelined data path and control – Handling Data hazards & Control hazards – Exceptions.

PARALLELISM: Instruction-level-parallelism – Parallel processing challenges – Flynn's classification – Hardwaremultithreading – Multicore processors.

MEMORY AND I/O SYSTEMS: Memory hierarchy - Memory technologies – Cache basics – Measuring and improving cache performance - Virtual memory, TLBs - Input/output system, programmed I/O, DMA and interrupts, I/O processors.

Text Books:

1. David A. Patterson and John L. Hennessey, "Computer organization and design', MorganKauffman / Elsevier, Fifth edition, 2014.
2. V.Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation ", VI edition, Mc Graw-Hill Inc, 2012.
3. William Stallings "Computer Organization and Architecture", Seventh Edition, Pearson Education, 2006.

4. Vincent P. Heuring, Harry F. Jordan, “Computer System Architecture”, Second Edition, Pearson Education, 2005.

Reference Books:

5. John P. Hayes, “Computer Architecture and Organization”, Third Edition, Tata Mc Graw Hill,1998.

Department Elective 2

EC365	Smart Antenna	DEC	3-0-0	3 Credits

Course Outcomes: After completion of the course student will be able to:

CO1	To Familiarize with smart and adaptive antennas.
CO2	To study about the different adaptive algorithms for the antenna.
CO3	Understanding the concept of direction of arrival and angle of arrival
CO4	To analyze the effect of mutual coupling and to study the space time.

Course Articulation Matrix

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	S	-	-	-	S	-	-	-	-	-	-	M	M
CO2	S	-	-	-	S	-	S	-	-	-	-	-	M	M
CO3	S	M	-	-	M	-	M	-	-	-	-	-	M	M
CO4	M	L	-	-	L	S	-	-	-	-	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction: Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Smart Antenna Configurations: Switched and Fixed Beam Antennas, Adaptive Antenna Approach, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.

Fixed Beam Smart Antenna Systems: Introduction, Conventional Sectorization, Antenna Arrays Fundamentals: Linear Arrays, Array Weighting, Circular Arrays, Rectangular Planar Arrays, Fixed Side lobe Canceling, Retro directive Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beam formers, SwitchedBeam Systems, Multiple Fixed Beam System.

Adaptive Array Systems: Uplink Processing: Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beamforming, Fixed Multiple Beams versus Adaptive Beamforming.
Downlink Processing: Transmit Diversity Concepts, Downlink Beamforming, Spatial Signature- Based Beamforming, and DOA-Based Beamforming.

Angle-of-Arrival Estimation: Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate,Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.

MIMO Antennas: Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual- Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO,SIMO, MISO, MIMO.

Textbooks:

1. Ahmed El Zooghby, ‘Smart Antenna Engineering’, ARTECH HOUSE, INC, 2005.
2. Frank B. Gross, „Smart antenna with MATLAB‟, 2nd Edition, McGraw-Hill, 2015.
3. Lal Chand Godara , “SMART ANTENNAS” , CRC PR ESS, 2004.
4. Shahid Mumtaz, Jonathan Rodriguez, “Ling long Dai mm Wave Massive MIMO: A Paradigm for 5G”.

EC366	Optical Communication	DEC	3–0–0	3 Credits

Course Outcomes: After completion of the course student will be able to:

CO1	Identify and characterize different components of an Optical Fiber Communication link.
CO2	Analyze optical source, Fiber and Detector operational parameters
CO3	Compute optical fiber link design parameters
CO4	Understand WDM, Optical Amplifiers, Optical Switching and networking technology concepts.

Course Articulation Matrix

CO \ PC	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	L	-	-	-	-	-	-	-	M	-
CO2	L	-	-	-	M	L	-	-	-	-	-	-	M	M
CO3	L	-	-	-	M	M	-	-	-	-	-	-	M	M
CO4	L	-	-	-	-	-	M	-	-	-	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Motivation for optical communications, advantages of optical fibers, optical bands, optical multiplexing standard, key elements of optical fiber communicationlink.

Optical windows, standards, few exercise problems. Linear polarization, optical laws, polarizer, fiber types, rays and modes, ray optics, Numerical aperture, optical fiber modes, evanescent tails, mode cutoff condition, wave equation in SI fibers, modes in SI fibers, LP modes, Single mode fibers, graded index fibers. Fiber materials, fiber fabrication, Fiber optic cables, exercise problems. Attenuation in fibers, absorption and scattering losses, bending losses, chromatic dispersion, modal delay, group delay, material dispersion, signal distortion in SM fibers, cutoff wavelength, mode field diameter, specialty fibers, exercise problems.

LED structures, light source materials, quantum efficiency and LED power, modulation of LED, exercise problems.Laser diode, structure, modes and threshold conditions, single mode lasers, modulation of laser diodes, external modulation, linearity, exercise problems.

Source to fiber power launching, lensing schemes, fiber to fiber joints, fiber splicing, fiber connectors, exercise problems. Photo diode principles, Avalanche photodiode, photo detectornoise, detector response time, structures for APD, exercise problems. Optical receiver operation, error sources, digital receiver performance, receiver sensitivity, eye pattern features, coherent detection.

Digital links, point to point links, link power budget, error control, Analog links, CNR, photo detectorand preamplifier noise.

WDM overviews, operational principles, WDM standards, optical coupler, star coupler, optical isolator, fiber Bragg grating, tunable optical filters, optical add/drop multiplexers, exercise problems. Optical amplifiers, basic operation, amplifier gain, Erbium doped fiber amplifiers, amplification mechanism, SONET/SDH transmission formats and speeds, optical cross connect switches, overview of traffic grooming in SONET ring.

Textbooks:

1. GERD KEISER, Optical Fiber Communications, TMH India, Fourth Edition, 2010.
2. SENIOR JOHN M., Optical Fiber Communications, Pearson Education India, Third

Edition,2009.

3. Olivier Bouchet, HerveSizun, Christian Boisrobert and Frederique De Forne, “Free-Space Optics: Propagation and Communication”, John Wiley and Sons, 2010.

EC367	FUZZY LOGIC & NEURAL NETWORKS	DEC	3-0-0	3 credits

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the fundamentals and types of neural networks
CO2	Explain the learning and adaptation capability of neural networks
CO3	Design, Analyze and train the neural network models
CO4	Describe the principles of knowledge based neural networks.
CO5	Understand engineering applications that can learn using neural networks
CO6	Understand the fuzzy sets, and apply the knowledge for representation usingfuzzy rules

Course Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	-	-	-	-	-	-	-	-	M	M
CO2	-	-	S	-	-	-	-	-	-	-	-	-	M	M
C03	-	-	-	-	-	-	M	-	-	-	-	-	M	M
C04	-	-	-	-	-	-	M	-	-	-	-	-	M	M
C05	-	-	-	-	-	-	-	-	S	-	-	-	M	M
C06	-	-	-	-	-	-	-	-	-	M	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

BASIC NEURAL COMPUTATIONAL MODELS: Basic concepts of Neural Nets (such as node properties, Network properties and Dynamics); Inference and learning (Data representation and functional classification); Classification models (single layer Perceptron, multi-layer perceptron); Association models (Hop field Nets, Bi- directional associative memories); Self organizing models (Kohonen Networks, Competitive learning, Hebbian learning).
LEARNING: Supervised and Unsupervised learning; Statistical learning; Neural Network learning (Back propagation, Radial basis Function Networks, ART Networks); Genetic Algorithms.

KNOWLEDGE BASED NEURAL NETWORKS & INCREMENTAL LEARNING: Rule-based Neural networks; Network Training; Decision Tree Based NN's; Principles; Symbolic methods; NeuralNetwork Approaches (Probabilistic NN's); Incremental RBCN.

NN APPLICATIONS: Signal Processing; Computer Vision; Medical Applications; Automated Inspection and Monitoring; Business and Finance.
FUZZINESS Vs PROBABILITY: Fuzzy Sets & Systems; The Geometry of Fuzzy sets; The FuzzyEntropy theorem; The subset hood Theorem; The Entropy Subset hood theorem.
FUZZY ASSOCIATIVE MEMORIES: Fuzzy & Neural Function Estimators; Fuzzy Hebbian FAMs;Adaptive FAMs.

COMPARISON OF FUZZY & NEURAL SYSTEMS: Case studies.

Textbooks:

1. Neural Networks in Computer Intelligence by Limin Fu, McGraw Hill Co., 1994.

2. Neural Networks & Fuzzy systems by B.Kosko, Prentice Hall (India) Ltd., 1992.
3. Neural Networks – A Comprehensive Foundation by S.Haykin, Maxell Macmillan International,1991.

EC368	Electronic Instrumentation	PCC	3–0–0	3 Credits

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Understand and estimate errors in a measurement system.
CO2	Identify the instrument suitable for specific measurements.
CO3	Estimate accurately the values of R, L and C employing suitable bridges.
CO4	Understand the basic principles of transducers for displacement, velocity, temperature and pressure.
CO5	Operate special measuring instruments such as Wave Analyzer and Harmonic Distortion Analyzer.
CO6	Identify data acquisition system for a specific application

Mapping of course outcomes with program outcomes:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	-	-	-	-	-	-	-	-	M	-
CO2	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO3	L	M	-	-	-	-	-	-	-	-	-	-	M	M
CO4	M	L	-	-	-	-	-	-	-	-	-	-	M	-
CO5	M	M	-	-	-	-	-	-	-	-	-	L	M	M
CO6	L	S	-	-	-	-	-	-	-	-	-	-	M	

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Measurement And Error: Sensitivity, Resolution, Accuracy and Precision, Absolute and Relative types of errors, Statistical analysis, Probability of Limiting errors, Linearity.

Instruments: Current and Resistance in instruments, Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q - meter; Noise and Interference reduction techniques in Measurement Systems, Wave Analyzer, Spectrum Analyzer, FFT Analyzer, Oscilloscopes: Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.

Transducers: Classification and selection of Transducers, Introduction to Strain, Load, Force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements; Introduction to Smart sensors and MEMS.

Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS, applications of DAS in various fields. General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Textbooks:

1. Electronic Measurements and Instrumentation, by Oliver and Cage, McGraw Hill.
2. Electronic Instrumentation & Measurement techniques, by W.D.Cooper & Felbrick, PHI.
3. Electronic Instrumentation and Measurements, by D.A. Bell, Reston.
4. H S Kalsi, Electronic Instrumentation, McGraw Hill, 3rd Edition, 2015.

IV- Year I –Semester

S.No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.		Management Course	3	0	0	03	HSC
2.		Department Elective –3	3	0	0	03	DEC
3.		Department Elective – 4	3	0	0	03	DEC
4.	EC401	Microwave and Light Wave Technologies	3	0	0	03	PCC
5.	EC402	Industry Related Subject	2	0	0	02	PCC
6.	EC403	Microwave and Light Wave Technologies lab	0	0	3	02	PCC
7.	EC449	Project work- Part A	0	0	8	04	PRC
Total			**14**	**0**	**11**	**20**	

EC 401	Microwave and Light Wave Technologies	PCC	3–0–0	3 Credits

Prerequisites: EC254 Transmission Lines and Electromagnetic Waves
Course Outcomes: After completion of the course student will be able to:

CO1	Understanding the S-Parameter analysis and operation of passive waveguide components.
CO2	Study the performance of specialized microwave tubes such as klystron, reflex klystron, magnetron and Travelling wave tube.
CO3	Identify and characterize different components of an Optical Fiber Communication link
CO4	Analyze optical source, Fiber and Detector operational parameters

Mapping of course outcomes with program outcomes:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	1	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	-	-	2	2
CO5	1	-	-	-	2	1	-	-	-	-	-	-	2	2

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

S matrix of transmission lines: three ports, Scattering matrix of four port microwave junctions. Elementary treatment of attenuators, terminations and twists, Diaphragms and posts, Tee Junctions, directional coupler, Magic tee, Faraday Rotation, Circulators and isolators, Cavity resonators and their applications, Strip line & Micro strapline components, Matrix representation of microwave junctions. **Microwave Sources:** Klystron amplifier, Reflex Klystron oscillator. Travelling Wave tube amplifier Cavity magnetron, Operation and applications of PIN Diode, Gunn diode

Optical fiber: Types, Step index fiber, Graded index fiber, Fiber materials, Mode theory for circular waveguides, wave equations in step index fibers, Modes in step index fiber and Graded index fiber. Attenuation mechanisms: Absorption, scattering losses, Bending losses, Core cladding losses, Signal distortion in single mode fibers, Polarization mode dispersion, Intermodal dispersion, Design optimization of single mode fibers.

Optical sources and Photodetectors: LED, LASER DIODES, Modes and Threshold conditions, PIN Photodetector, Avalanche photo diode, Comparison of Photodetectors, Transmission Link Analysis, Point to point links, Link Power budget.

Textbooks:

1. Pozar, D.M., “Microwave Engineering”, 4th Ed., John Wiley & Sons, 2012.
2. Liao, S.Y., “Microwave Devices and Circuits”, 3rd Ed PEARSON INDIA. 2000.
3. Collin, R.E., “Foundations for Microwave Engineering”, 2nd Ed.,John Wiley & Sons.2001.
4. G.KEISER, Optical Fiber Communications, 4th Ed., MGH, 2010.
5. J. GOWAR, Optical Communication Systems, PHI, 2nd Ed. 1993.

EC403	Microwave and Light wave Technologies Lab	PCC	0–1–2	2 Credits

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Measure performance of simple microwave circuits and devices.
CO2	Perform microwave measurements with sophisticated instruments such as vector network analyzer and spectrum analyzer
CO3	Assess the performance of optical devices: light sources, fibers and detectors.
CO4	Plot the loss characteristics of optical fibers.

Mapping of COs with POs:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	M	-	-	-	-	-	-	-	-	-	-	M	M
CO2	L	M	-	-	-	-	-	-	-	-	-	-	M	M
CO3	-	M	-	-	L	-	-	-	-	-	-	-	M	M
CO4	L	M	-	-	-	-	-	-	-	-	-	-	M	M

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List of Experiments:

Antenna Demonstration
Mode characteristics of Reflex Klystron
Gunn oscillator characteristics and power measurement
Measurement of VSWR & impedance
Measurement of radiation pattern and gain of an antenna
Properties of circulators & Directional coupler
Properties of the Magic Tee Junction
S-parameter measurement of microstrip components.
Vector Network Analyzer Demonstration
Measurement of Numerical Aperture
Study of Optical Sources, Detectors and Fiber Characteristics

Department Elective 3

EC411	Cellular and Mobile Communications	PCC	3–0–0	3 Credits

Prerequisites: Analog and Digital Communications

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the evolution of cellular communication systems upto and beyond 3G
CO2	Design a cellular link and estimate the power budget.
CO3	Choose proper multiple accessing methods depending on channel model
CO4	Identify traffic channels for call processing
CO5	Calculate key performance metrics of a cellular communication system.

Course Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	L	M	M	-	-	-	-	-	M	-
CO2	M	-	-	-	M	M	L	-	-	-	-	M	M	M
CO3	M	-	-	-	M	M	L	-	-	-	-	-	M	M
CO4	L	-	-	-	M	-	L	-	-	-	-	-	M	M
CO5	M	-	-	-	S	M	M	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

An Overview of Wireless Systems - Introduction - Everything moves - Mobility versus portability - Mobile devices – Wireless communication and the layer model - First- and Second- Generation Cellular Systems - Cellular Communications from 1G to 3G - Road Map for Higher Data Rate Capability in 3G - Wireless 4G Systems - Future Wireless Networks – Standardization Activities for Cellular Systems.
Cellular System design concepts and fundamentals - Frequency Reuse – Channel Assignment- Handoff Strategies – Interference and System Capacity – Trunking and Grade of service – Improving Coverage and Capacity in cellular systems.

Mobile Radio Wave propagation - large scale path loss and propagation models – Reflection – Diffraction – Scattering – Practical link budget design – Outdoor propagation models – Indoor propagation models. Small Scale fading and multipath propagation, Rayleigh and Rician Distributions.
Multiple Access Techniques for Wireless Communications: FDMA – TDMA – Introduction to OFDM, Spread Spectrum multiple access – FHMA, CDMA – SDMA, capacity of cellular systems.
Equalization and Diversity: Fundamentals of equalization, General adaptive equalizer, Linear and non-linear equalizers, diversity techniques, RAKE receivers.
Introduction to 5G and B5G: An Overview of 5G Requirements**,** Spectrum Analysis and Regulations for 5G**,** Spectrum Sharing for 5G and Overview of 5G communication technologies: (OMA, NOMA, Tera Hertz communications, milli meter wave technologies and Reconfigurable Intelligent Surfaces)

Textbooks:

1. William C Y Lee, “Mobile Cellular Telecommunications, McGraw Hill. (Main Book)

2. Stallings, *Wireless Communications and Networks*, 1st Ed., Prentice Hall, 2015.
3. Schwartz, *Mobile Wireless Communications*, Cambridge University Press. (Main Book)
4. Theodore S Rappaport, "Wireless Communications Principles and Practice", 2nd Ed., Prentice Hall, 2002.
5. Xiang, Wei, Kan Zheng, and Xuemin Sherman Shen, eds. *5G mobile communications*. Springer, 2016.

EC412	Satellite Communication	DEC	3–0–0	3 Credits

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the orbital and functional principles of satellite communication systems
CO2	Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems
CO3	Analyze and evaluate a satellite link and suggest enhancements to improve link perromance.
CO4	Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.
CO5	Specify, design, prototype and test analog and digital satellite communication systems as per given specifications.

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	-	M	L	M	L	-	-	-	-	-	M	M
CO2	L	-	-	L	M	M	M	-	-	-	-	-	M	M
CO3	-	-	-	-	M	M	L	-	-	-	-	-	M	M
CO4	L	-	-	-	S	M	L	-	-	-	-	L	M	M
CO5	L	L	-	-	S	M	L	-	-	-	-	L	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction: Overview of Satellite Communications, Types -Active and Passive Satellite, Frequency allocation, types of Satellite orbits, Kepler's laws, Definitions of terms for earth-orbiting satellites, orbital parameters ,Two line elements, Apogee and Perigee heights, Orbit perturbations, GEO, MEO and LEO satellite systems,frequency bands, Geo stationary orbit, Antenna look angles, Limits of visibility, Sub satellite point and prediction of satellite position, Earth Eclipse of satellite, Sun transit outage, launching orbits – Launch vehicle - expendable and reusable type. **Orbital Mechanics:** Orbit Equations, Locating the satellite w.r.t. the earth, Orbital elements, look Angles, Orbital perturbation, Effects of earth's oblate ness, moon and sun, Satellite eclipse, suntransit outage, Coverage angle, slant range, satellite launching.

Satellite subsystems: Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command System (TT&C), Power System, Satellite antennas, Communications subsystem, transponders.

Satellite Link Design: Basic transmission theory, System noise temperature and G/T ratio, CNR, CIR, ACI, IMI, down link design, up link design, System design examples, the Power supply, Attitude control, spinning satellite stabilization, Momentum wheel stabilization, Station Keeping, Thermal control, TT&C subsystem, Transponders, The wide band receiver, The input demultiplexer, the power amplifier, the antenna subsystem.

Modulation and Multiplexing: FM with multiplexed telephone signals, Analog FM SCPC, PSK, QPSK, Multiple Access Schemes: FDM/FM/FDMA, TDMA, On-board processing, CDMA, Spread spectrum transmission and reception, DS-SS CDMA capacity, Error Control for Digital Satellite Links: Error control coding, VSAT Systems: Overview of VSAT systems, LEO Satellite systems: Orbits, Coverage and frequency bands, off axis scanning, delay andthroughput.

Text books:

1. TIMOTHY PRATT, CHARLES BOSTIAN JERMEY ALLNUTT, Satellite Communications,Wiley India, Second Edition, reprint 2020.
2. M. RICHHARAIA, Satellite Communication Systems, BS Publishers, Second Edition, 2008.
3. TRI.T. HA, Digital Satellite Communications, McGraw-Hill, 2000.
4. Dennis Roddy, “Satellite communication”, 4th Edition - Tata Mc Graw Hill Co.Special Indian reprint 2013.
5. Zhili Sun-John, “Satellite Networking Principles and Protocols”, 2nd Edition Wiley and Sons 2014.
6. K.N.Raja Rao, “Fundamentals of Satellite communication”. PHI 2004.

EC413	Digital Image Processing	DEC	3–0–0	3 Credits

Prerequisites: None

Course Outcomes: After the completion of the course student will be able to:

CO1	Understand the need for image transforms and their properties.
CO2	Choose appropriate technique for image enhancement both in spatial and frequency domains.
CO3	Identify causes for image degradation and apply restoration techniques.
CO4	Compare the image compression techniques in spatial and frequency domains.
CO5	Select feature extraction techniques for image analysis and recognition.

Mapping of course outcomes with program outcomes:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	M	-	-	-	-	-	-	M	M
CO2	M	S	-	-	-	-	-	-	-	-	-	-	M	M
CO3	M	S	-	-	-	-	-	-	-	-	-	-	M	M
CO4	-	S	-	-	-	-	-	-	-	-	-	-	M	M
CO5	-	S	-	-	-	-	-	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

INTRODUCTION: Digital Image Representation, Fundamental Steps in Image Processing, Elementsof Digital Image Processing Systems.

DIGITAL IMAGE FUNDAMENTALS: Elements of Visual Perception, A Simple image model, Sampling and Quantization, Neighbourhood of Pixels, Pixel Connectivity, Labelling of Connected Components, Distance Measures, Arithmetic and Logic Operations, Image Transformations, Perspective Transformations, Stereo Imaging.

IMAGE ENHANCEMENT: Spatial Domain Methods, Frequency Domain Methods, point processing, Intensity Transformations, Histogram Processing, Spatial filtering, Smoothing Filters, Sharpening Filters, Enhancement in the Frequency Domain, Low Pass Filtering, High Pass Filtering, Homomorphic filtering.

WAVELETS and MULTIRESOLUTION PROCESSING: Sub band Coding, Haar Transform, Multiresolution Series Expansions, Wavelet Transforms in One Dimension, Discrete Wavelet Transform, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets. **IMAGE COMPRESSION**: Fundamentals of Compression, Image Compression Model, Error free Compression, Lossy Predictive Coding, and Transform Coding.

IMAGE SEGMENTATION: Detection of Discontinuities, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Thresholding, Threshold Selection on Boundary Characteristics, Region Growing, Region Splitting and Merging, Use of motion in Segmentation.

IMAGE REPRESENTATION AND DESCRIPTION: Chain Codes, Polygonal Approximations, **Signatures**, Skeleton, Boundary Descriptions, Shape Numbers, Fourier descriptors, Moments, Topological Descriptors.

IMAGE RECOGNITION AND INTERPRETATION: Elements of Image Analysis, Pattern and Pattern classes, Minimum Distance Classifier, Matching by Correlation, Baye's Classifier, Neural Network Training Algorithm, Structural methods.

Text books:

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, Prentice Hall, 3rd Edition, 2008.
2. B. Chanda, D. Dutta Majumder, Digital Image Processing and Analysis, PHI, New Delhi, 2000.
3. A.K. Jain, Fundamentals of Digital Image Processing, PHI, New Delhi, 2001.

EC414	Low Power VLSI	DEC	3-0-0	3 Credits

Prerequisites: CMOS VLSI Design

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify clearly the sources of power consumption in a given VLSI Circuit.
CO2	Implement Low power design approaches for system level and circuit level measures.
CO3	Implement logic styles for low power logic synthesis
CO4	Decide at which level of abstraction is advantageous to implement low power techniques in a VLSI system design.

Course Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	-	L	L	-	-	-	-	-	--	-	M	M
CO2	-	-	-	S	-	-	-	-	-	-	-	-	M	M
CO3	-	M	-	M	S	-	-	-	-	-	-	L	M	M
CO4	-	-	-	L	-	-	-	-	-	-	-	-	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction: Sources of Power Dissipation, Static Power Dissipation, Active Power Dissipation, Circuit Techniques for Leakage Power Reduction.

Supply voltage scaling approaches: Device feature size scaling, Multi-V_{DD} Circuits, Architectural level approaches: Parallelism and Pipelining, Voltage scaling using high-level transformations, Dynamic voltage scaling, Power Management.

Switched Capacitance Minimization Approaches: Hardware Software Tradeoff, Bus Encoding, Two's complement Vs Sign Magnitude, Architectural optimization, Clock Gating, Logic styles.

Memories: Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques

Leakage Power minimization Approaches:

Variable-threshold-voltage CMOS (VTCMOS) approach, multi-threshold-voltage CMOS (MTCMOS) approach, Power gating, Transistor stacking, Dual-V_t assignment approach (DTCMOS).

Adiabatic Logic Circuits, Battery-Driven System, CAD Tools for Low Power VLSI Circuits.

Text books:

1. Ajit. Pal, Low power VLSI Circuits and systems, 1st Edition, Springer, 2015.
2. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.

Refence Books:

1. Jan Rabaey, Low Power Design Essentials, 1st Edition, Springer, 2009.
2. Kiat Seng Yeo and Kaushik Roy, Low- Voltage, Low-Power VLSI Subsystems, Edition 2009,Tata Mc Graw Hill.

Department Elective 4

EC415	Advanced Radar Technologies	DEC	3-0-0	3 credits

Course Outcomes: After the completion of the course student will be able to:

CO1	Understand the basic operation of pulse and CW radar systems.
CO2	Evaluate the radar performance based on pulse width, peak power and beam width.
CO3	Choose suitable tracking radar for a given problem.
CO4	Select appropriate criterion for detecting a target.
CO5	Understand the working of phased array radars and navigational aids

Course Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	-	-	-	-	-	-	-	-	-	-	-	M	-
CO2	-	S	-	-	-	-	-	-	-	-	-	-	M	M
CO3	M	M	-	-	-	L	-	-	-	-	-	-	M	M
CO4	M	-	-	-	L	-	-	-	-	-	-	-	M	M
CO5	M	M	-	-	-	-	-	-	-	-	-	L	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Radar and Radar Equation: Introduction, Radar block diagram and operation, frequencies, applications, types of displays, derivation of radar equation, minimum detectable signal, probability of false alarm and threshold detection, radar cross-section, system losses.

CW Radar – Doppler Effect, CW Radar, applications, FM – CW radar, altimeter, Multiple Frequency Radar. Pulse Radar – MTI, Delay Line Canceller, Multiple Frequencies, Range-gated Doppler Filters,Non-coherent MTI, Pulse Doppler Radar.

Tracking Radar- Sequential lobing, conical scanning, mono pulse, phase comparison mono pulse, tracking in range, comparison of trackers.

Detection – Introduction, Matched Filter, Detection Criteria, Detector characteristics.

Phased Arrays – Basic concepts, feeds, phase shifters, frequency scan arrays, multiple beams,applications, advantages and limitations. Navigational Aids: Direction Finder, VOR, ILS and Loran.

Text books:

1. M.I. Skolnik, Introduction to Radar Systems, 3rd Edition, Mc Graw Hill Book Co., 2000.
2. F.E. Terman, Radio Engineering, Mc Graw Hill Book Co. (for Chapter 7 only), Fourth Edition 1955
3. Simon Kingsley & Shaun Quegan, Understanding RADAR Systems, McGraw Hill Book Co., 1993.

EC416	Fundamentals of MIMO Wireless Communications	PCC	3–0–0	3 Credits

Prerequisites: Analog and Digital Communications

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the evolution of mobile communication systems upto 5G
CO2	Choose proper multiple accessing methods depending on channel model
CO3	Understand the antenna diversity and space diversity techniques
CO4	Calculate capacity of MIMO channels under various scenarios

Course Articulation Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	L	M	M	-	-	-	-	-	M	-
CO2	M	-	-	-	M	M	L	-	-	-	-	M	M	M
CO3	M	-	-	-	M	M	L	-	-	-	-	-	M	M
CO4	L	-	-	-	M	-	M	-	-	-	-	-	M	M
CO5	M	-	-	-	S	M	M	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

The Wireless Channel: Large scale fading: general pathloss models, Okumura/Hata model, small scale fading: coherence time, coherence bandwidth, doppler spread, and delay spread, linear time varying system interpretation, classification of fading, statistical characterization, Raleigh and Rician fading, MIMO channel model, Narrowband MIMO Channel.

MIMO Channel Capacity: Deterministic MIMO channel capacity, Channel capacity when CSI is known to the transmitter side, Channel capacity when CSI is unknown to the transmitter side, Channel capacity of SIMO, and MISO channels.

Antenna Diversity and Space-time Coding: Antenna diversity: receiver diversity, transmit diversity, space-time coding: system model, pairwise error probability, space-time code design, Alamouti Space-time code, generalization of space-time block coding, decoding of space-time block codes.

Orthogonal Frequency Division Multiplexing: Single carrier, and Multicarrier transmission, OFDM modulation and demodulation, OFDM Guard interval, OFDM Guard Band, BER of OFDM scheme, OFDMA: multiple access extension of OFDM.

Text books:

1. Yong Soo Cho, Jackwon Kim, Won Young Yan, Chung-Gu Kang, MIMO – OFDM Wireless Communications with MATLAB, 1st Ed., Wiley, 2010.
2. Rakesh Sing Kshetrimayum, Fundamentals of MIMO Wireless Communications.
3. William C Y Lee, “Mobile Cellular Telecommunications, McGraw Hill. (Main Book)
4. Theodore S Rappaport, “Wireless Communications Principles and Practice”, Prentice Hall.

EC417	Introduction to Machine Intelligence	PCC	3–0–0	3 Credits

Introduction: A brief history of MI/ML, features, perceptrons, probabilities, sets and statistics.

Data Compression: PCA and t-SNE, Fisher vector, VLAD, Other encoding methods, K-fold cross validation, leave-one-out.

Classification and clustering: K-means and FCM, Support vector Machines and self-organizing maps.

Learning: Perceptrons, MLPs and Backpropagation algorithms.

Deep learning: autoencoders and convolutional neural networks (CNN), Reinforcement agents.

Uncertain and Vague knowledge: evolving fuzzy inference systems, Decision trees, random forests.

Probabilistic methods: Naïve Bayesian, Hidden Markov Models.

Evolution and animals: evolutionary algorithms and Differential evolution, ant colonies and particle swarms.

Text books:

1. Machine Learning – Tom M. Mitchell, - MGH, 1997.
2. Machine Learning: An Algorithmic Perspective, Stephen Marshland, 2nd Ed., Taylor & Francis

EC418	Software Defined and Cognitive Radio	DEC	3-0-0	3 credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand and explain common SDR and CR hardware and networks architecture
CO2	Identify the blocks of SDR for a specific application
CO3	Demonstrate knowledge of spectrum sensing approaches developed for CRN
CO4	Analyze the transmitter and receiver architectures in SDR

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	-	2	-	-	-	-	-	-	-	2	2
CO2	1	2	-	-	2	-	-	-	-	-	-	-	2	2
CO3	-	-	-	-	3	2	1	-	-	-	-	-	2	2
CO4	-	-	-	-	3	2	1	-	-	-	-	2	2	2

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction to Software Defined Radio – benefits of SDR, Hybrid Radio Architecture, Basic SDR Block Diagram, System Level Functioning Partitioning, Digital Frequency Conversion Partitioning.

RF System Design – Introduction- Noise and Channel Capacity- Link Budget- Receiver Requirements- Multicarrier Power Amplifiers- Signal Processing Capacity Tradeoff. Analog-to-Digital and Digital-to-Analog Conversion- Introduction – Digital Conversion Fundamentals- Sample Rate- Bandpass Sampling- Oversampling- Anti alias Filtering – Quantization.

Digital Frequency Up- and Down Converters- Introduction- Frequency Converter Fundamentals- Digital NCO- Digital Mixers- Digital Filters- Half band Filters- CIC Filters- Decimation, Interpolation, and Multi rate Processing-DUCs - Cascading Digital Converters and Digital Frequency Converters.

Hardware and Software components- SDR hardware requirements, Digital Signal Processors, FPGAs, Hardware Specific Software Architecture, Software Standards for Software Radio-Software DesignPatterns, Real Time Operating Systems

Introduction to cognitive radio: Overview of Cognitive radio concept, Application scenarios, CR Network architecture, underlay, overlay, interweave, **Spectrum Sensing:** Primary user detection, Match Filter detection, Energy detection, Sensing control, in band/Out of band, Cooperative spectrum sensing, compressive sensing, Dynamic Spectrum Access: Spectrum decision, spectrum sharing, Cognitive features in the current and future wireless standards.

Text books:

1. Tony J. Rouphael, "RF and Digital Signal Processing for Software-Defined Radio: A Multi-Standard Multi-Mode Approach," Elsevier, 2009.
2. Charles W. Bostian, Nicholas J. Kaminski & Almohanad S. Fayed, "Cognitive Radio Engineering," Scitech, 2016.

3. Ezio Biglieri et al., “Principles of Cognitive Radio,” Cambridge University Press, 2013.
4. Jouko Vanakka, Digital Synthesizers and Transmitter for Software Radio, Springer, 2005.
5. P Kenington, RF and Baseband Techniques for Software Defined Radio, Artech House, 2005.

SM430	Entrepreneurship for Engineers	HSC	3 – 0 – 0	3 Credits

Course outcomes: At the end of the course, the student will be able to:

CO1	Acquaint themselves with starting new ventures and introducing new products and service ideas
CO2	Explore the processes of establishing a start-up
CO3	Develop strategies and methods to mobilize resources
CO4	Create venture capitalists, consultants to new firms or new business development units of larger corporates

Detailed syllabus:

The Early Career Dilemmas of an Entrepreneur: Discover ourselves- The Entrepreneur's Role, Task and Personality- A Typology of Entrepreneurs: Defining Survival and Success, Entrepreneurship as a Style of Management- The Entrepreneurial Venture and the Entrepreneurial Organisation- Identify Problems Worth Solving-Customer Identification- Choosing a Direction Opportunity recognition and entry strategies- Business model identification- validation- New product Franchising-Partial Momentum- Sponsorship and Acquisition- The Strategic Window of Opportunity- Scanning-Positioning and Analysing, Intellectual Property-Creation and Protection

Gaining Commitment- Gathering the Resources- The Business Plan as an Entrepreneurial Tool- Financial Projections: how to do them the right way- Debt-Venture Capital and other forms of Financing-Sources of External Support-Developing Entrepreneurial Marketing-Competencies- Networks and Frameworks-ustaining Competitiveness- Maintaining Competitive Advantage- The Changing Role of the Entrepreneur- Mid- Career Dilemmas-Harvesting Strategies versus Go for Growth

Characteristics and special needs- Business/project planning- Business Plan preparation- Implementation Process- Planning support systems (enterprise operation)- Legal Issues (licensing, patents, contracts etc.)-Effectuation and Causation-Art of negotiation-Conflict Management

References:

1. B.D.Singh. Managing Conflict and Resolution. Excel Books.2008
2. R. Barringer and D. Ireland, Entrepreneurship, Prentice Hall,2009.
3. G. Kawasaki, L. Filby, The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything , Penguin,2015.

4. R. Bansal, Connect the Dots, Westland,2011.
5. Ries,Eric The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Business,2011.
6. S. S. Khanka, Entrepreneurial Development, S.Chand&Co.2006.
7. S. Blank and B. Dorf, Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, K&S Ranch Publishing,2012.

IV - Year II –Semester (2021-2022), Proposed

S. No	Course No.	Course Title	L	T	P	Credits	Cat. Code
1.		Department Elective – 5	3	0	0	03	DEC
2.		Open Elective	3	0	0	03	OPC
3.	MEC401	MOOCS-2	2	0	0	02	MOOC
4.	EC499	Project-Work Part – B (with optionof Industrial Training /Internship)	0	0	12	06	PRC
Total			**8**	**0**	**12**	**14**	

Department Elective 5

EC461	Advanced Wireless Communication: 5G and beyond	DEC	3-0-0	3 credits

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand 5G cellular standard architecture and key capabilities
CO2	Understand the key enabling technologies for 5G Physical layer (New Radio Interface)
CO3	Understand the key enabling technologies for next generation (6G and beyond) wireless standards
CO4	do system level simulation and performance evaluation of physical layer algorithms for 5G and beyond wireless systems
CO5	apply machine/deep learning in next generation wireless communication

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	1	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	-	-	2	2

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Fundamentals of wireless communication: Wireless Channel (channel modelling, large scale propagation effects, small scale propagation effects, implications of delay and doppler spread,), Orthogonal frequency division multiplexing (multi-carrier modulation, OFDM transmitter/receiver design, cyclic prefix), Multiple antenna technique (MIMO transmitter/receiver, advantages of multiple antennas, diversity and spatial multiplexing gain, space-time coding, MIMO receiver).

5G Wireless Standard: Review of 2G, 3G and 4G cellular standards, requirements and evaluation of 5G standard, 5G use cases, 5G architecture, 5G New Radio (NR) network interfaces, 5G frequency bands, 5G NR Numerology, 5G channel types, 5G NR physical layer overview, 5G NR MAC layer overview, 5G NR RLC layer, 5G Core architecture and network functions, Coexistence and interworking with LTE.

Key 5G and Beyond Enabling Technologies : Advanced Channel coding techniques: Low density parity check codes and Polar codes (Encoder and decoder implementation), Waveforms and air interfaces:(FBMC (filter bank multi-carrier), UFMC (universal filtered multi-carrier), GFDM (generalized frequency division multiplexing), NOMA (Non orthogonal multiple access) , Massive MIMO Systems: motivation and system model, advantages and challenges, uplink and downlink transmission, spectral and energy efficiency, cell free massive MIMO systems, Millimeter wave Communication: mm Wave channel modelling, advantages and challenges, mm Wave channel estimation and beamforming, Intelligent Reflective surfaces, Cooperative and full duplex communication systems. **Deep/Machine Learning for Wireless Communication**: Overview of DL/ML model, Data set generation and acquisition for wireless communication, Application examples of ML/DL in wireless communication physical layer algorithm design e.g. modulation design, massive MIMO channel estimation, MIMO receiver design etc.,

Text books:

1. T. Marzetta, E. Larsson, H. Yang, and H Ngo, “Fundamentals of Massive MIMO. Cambridge”, Cambridge University Press, 2016.
2. Eric dahlman et al., 5G NR, The Next generaton Wireless access technolgy, Academic Press, 2021.
3. Ali Zaidi et al., 5G Physical layer, Principles, Models and Technolgy Components, Academic Press, 2018.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock “MillimeterWave Wireless Communications”, Prentice Hall Communications.
5. E. Björnson, J. Hoydis and L. Sanguinetti, “Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency”, Foundations and Trends in Signal Processing: Vol. 11, No. 3-4, pp 154–655, (2017).
6. D. Tse and P. Viswanath, “Fundamentals of Wireless Communication”, Cambridge university press, 2nd Edition, 2005.

EC462	Forensic Signal and Image Processing	DEC	3–0–0	3 Credits

Prerequisites: Fundamentals of Audio Signal and Image Processing
Course Outcomes: After the completion of the course student will be able to:

CO1	Understand the standards and Practices in Multimedia Forensic.
CO2	Learn the basics of Audio and Image Forensics
CO3	Learn the security applications of signal processing algorithms

Mapping of course outcomes with program outcomes:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	M	-	-	-	-	-	-	M	M
CO2	M	S	-	-	-	-	-	-	-	-	-	-	M	M
CO3	M	S	-	-	-	-	-	-	-	-	-	-	M	M
CO4	-	S	-	-	-	-	-	-	-	-	-	-	M	M
CO5	-	S	-	-	-	-	-	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

INTRODUCTION:
Standards and Practices in Multimedia Forensic, ISO standards, Electronic Evidence and Digital Forensics, Multimedia Evidence, General Quality Assurance.
Audio Forensic:
Fundamentals of Audio Signals and Systems, Sound, Sound Pressure level, Wave Propagation and Spherical Spreading**,** Digital Audio, Perceptual Audio Coding, History of Audio Forensic, Handling Forensic Evidence, Authenticity Assessment.
Authenticity Assessment:
Authenticity of Digital Audio Recording, Identifying Edits: Splicing and Mixing, Assessing reverberation and background sound level in Forensic Audio recording, Electrical Network Frequency Analysis, Metadata Consistency
Digital Image Forensic:
Introduction and Background of Digital Image Forensic, detecting region duplication, Exposing Splicing Forgery, Camera based Image Forgery detection.
Applications:
Steganography, watermarking, and fingerprinting: algorithms for hiding, recovering, detecting and distorting embedded signals.

Text books:

1. Robert C Maher, "Principles of Forensic Audio Analysis", Springer, 2018.
2. Brian E D, E J Smith, "Forensic Digital Image Processing Optimization of Impressive Evidence", CRC Press, 2018.
3. Anthony T.S Ho, Shunjun Li, "Handbook of Digital Forensics of Multimedia Data and Devices", John Wiley and Sons, 2015.

EC463	VLSI Signal Processing	DEC	3-0-0	3 Credits

Prerequisites: Digital Signal Processing

Course Outcomes: After completion of the course student will be able to:

CO1	Understand IC design flow for signal processing applications.
CO2	Develop the knowledge of signal processing algorithms like Convolution, Correlation, FFT, FIR filters.
CO3	Learn design of systolic architectures.
CO4	Solve practical and state of the art signal processing algorithms using VLSI architectures to serve industries.

Course Articulation Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction: Typical Signal Processing Algorithms, Overview of VLSI Architectures, Representations of DSP Algorithms. Iteration Bound, Pipelining, Parallel Processing, Definitions and Properties, General Methodology, Unfolding Algorithm, Critical Path, Unfolding, and Retiming, Folding Transformation, Register Minimization.

Systolic architecture design: Overview, Design Methodology, Matrix Operations and 2D Systolic Array design, Parallel Algorithm Expressions, Canonical Mapping Methodology, Generalized Mapping.

Bit-level arithmetic architectures: Parallel multipliers, Bit-serial multipliers, Bit-serial filter design and implementation.

Programmable DSPs: Important Features, DSP Processors for Mobile and Wireless Communications, Processors for Multimedia Signal Processing.

Text books:

1. "VLSI Digital Signal Processing Systems", Keshab K. Parhi, Wiley Eastern
2. "Digital Signal Processing for Multimedia Systems", Keshab K. Parhi and Takao Nishitani, Marcel Dekker.
3. "Pipelined Lattice and Wave Digital Recursive Filters", J. G. Chung and Keshab K. Parhi, Kluwer.
4. "VLSI Array Processors", S.Y.Kung, Prentice-Hall, 1988.

EC464	Microwave Integrated Circuits	PCC	3–0–0	3 Credits

Prerequisites: EC254 Transmission Lines and Electromagnetic Waves

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the basics of Scattering matrix and two port characterization and signal flow graphs.
CO2	Analyse the working principles and design of couplers and power dividers.
CO3	Design the different types of microwave filters and their implementation
CO4	Understand the design complexities of microwave amplifier and its stability features.
CO5	Understand the design complexities of oscillators and mixers.

Course Articulation Matrix:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	M	-	-	-	-	-	-	-	-	-	-	-	M	-
CO2	-	S	-	-	-	-	-	-	-	-	-	-	M	M
CO3	M	M	-	-	-	L	-	-	-	-	-	-	M	M
CO4	M	-	-	-	L	-	-	-	-	-	-	-	M	M
CO5	M	M	-	-	-	-	-	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Microwave Network Analysis: Impedance and Equivalent Voltages and Currents, Impedance and Admittance Matrices, Transmission (ABCD) Matrix, Signal Flow Graphs.

Power Dividers and Couplers: Basic Properties of Dividers and Couplers, Scattering matrix of 3- and 4-port junctions; Design of T-junction and Wilkinson power dividers; Design of Coupled Line Coupler, Design of hybrids 90º and 180º.

Microwave Planar Filters: Periodic structures, Filter design by the Image Parameter method, Filter design by the Insertion Loss method, Filter transformations, Filter implementation, Stepped-Impedance Low-Pass filters, coupled line filters, Filters using coupled resonators.

Microwave Amplifier Design: Two-Port Power Gains, Stability of an Amplifier, Stability Circle, Design for Maximum Gain (Conjugate Matching), Constant Gain Circles and Design for Specified Gain, Noise, Noise figure circles, Design of Low-Noise Amplifier. Classification of Power Amplifier, Design of Class A Power Amplifiers.

Oscillators and Mixers: One-port oscillator, Load matching circuit for the one-port oscillator, Two-port oscillator, Design of two-port transistor oscillator. Single Ended Mixers, Single Balanced Mixers, Double Balanced Mixers, Image Reject Mixers.

Text books:

1. Pozar, D.M., “Microwave Engineering”, 4th Ed., John Wiley & Sons, 2012.
2. Collin, R.E., “Foundations for Microwave Engineering”, 2nd Ed.,John Wiley & Sons.2000.
3. iao, S.Y., “Microwave Devices and Circuits”, Prentice-Hall of India. 1991.

Course offered by ECE department to II-year CSE students

EC237	DIGITAL LOGIC DESIGN	ESC	2 – 0 – 2	4 Credits

Pre-requisites: EC101-Basic Electronic Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand number representation and Boolean algebra. Design digital components.
CO2	Compile and Simulate Verilog models of digital circuits using CAD tool.
CO3	Analyze digital systems and improve the performance by reducing complexities.
CO4	Design of combinational and sequential logic circuits and develop Verilog models.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	L	L	L	-	-	-	-	-	-	S	S
CO2	S	S	M	L	-	-	-	-	-	-	-	-	S	S
CO3	S	S	S	M	L	M	-	-	-	-	-	-	S	S
CO4	S	S	S	S	M	L	-	-	-	-	-	L	S	S

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed syllabus:

Digital Hardware, Design Process, Structure of a computer, Digital representation of Information.

Variables and functions, Logic Gates and networks, Boolean algebra, Synthesis using AND, OR, NOT gates, Design examples, Introduction to CAD tools and Verilog HDL. Implementation of Logic functions, Minimization and k-maps, Product-of-sums Form, incompletely specified functions. Multiple output circuits. Positional Number representation, Additions of unsigned and signed number, FastAdders, Design of Arithmetic Circuits using CAD tools. Combinational Circuit Building blocks – Multiplexers, Decoders, encoders, Code converters, Arithmetic Comparison Circuits, Verilog for Combinational circuits.

Flip-Flops, Registers and Counters – Basic Latch, SR and D latches, Edge triggered D Flip-flop, T and JK Flip Flops. Registers, Synchronous and Asynchronous Counters. Reset Synchronization, using storage elements with CAD tools, Using Verilog constructs for Registers and Counters.

Synchronous Sequential circuits – Basic design steps,State Assignment problem. Moore and Mealy State models, Design of Finite State Machines using CAD tools.

Reading List:

1. S. Brown, Z. Vranesic, *Fundamentals of Digital Logic with Verilog Design*, McGrawHill, third edition, 2014.
2. W. I Fletcher, *An Engineering approach to Digital Design*, Eastern Economy edition,PHI Limited, 2000.
3. J. Bhasker, Verilog Primer, 3rd edition, Prentice-Hall India, 1998.
4. S. Palnitkar, Verilog HDL: A guide to digital Design and Synthesis, 2nd edition, Pearson, 2003.

EC337	Microprocessor	PCC	3-0-2	4 Credits

Pre-requisites:

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the evolution of microprocessors
CO2	Understand assembly language programming basics for 8085
CO3	Understand the basic serial I/O and interrupt mechanism used in 8085
CO4	Understand the data transfer techniques using microprocessor
CO5	Understand the typical 16-bit microprocessor

Course Articulation Matrix:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S	-	S	-	-	-	-	-	-	-	-	M	-
CO2	-	S	-	S	-	-	-	-	L	-	-	-	M	-
CO3	-	S	-	-	-	-	-	-	L	-	-	-	M	-
CO4	-	M	-	S	-	-	-	-	L	-	-	-	M	-
CO5	-	M	-	S	-	-	-	-		-	-	-	M	-

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Introduction to Microprocessors: History and Evolution, types of microprocessors, Microcomputer Programming Languages, Microcomputer Architecture, Intel 8085 Microprocessor, Register Architecture, Bus Organization, Registers, ALU, Control section, Instruction set of 8085, Instruction format, Addressing modes, Types of Instructions**.**

Assembly Language Programming and Timing Diagram: Assembly language programming in 8085, Macros, Labels and Directives, Microprocessor timings, Micro instructions, Instruction cycle, chine cycles, T-states, State transition diagrams, Timing diagram for different machine cycles.

Serial I/O and Interrupts: Serial I/O using SID, SOD. Interrupt in 8085, RST instruction, Issues in implementing interrupts, Multiple interrupts and priorities, Daisy chaining, interrupt handling in 8085, Enabling, Disabling & masking of interrupts.

Data Transfer techniques: Data transfer techniques, Parallel & Programmed data transfer using 8155. Programmable parallel ports & handshake input/output, Asynchronous and Synchronous data transfer using 8251. PIC (8259), PPI (8255), DMA controller (8257).

Architecture of Typical 16-Bit Microprocessors: Introduction to a 16-bit microprocessor, Memory address space and data organization, Segment registers and Memory segmentation, generating a memory address, I/O address space, addressing modes, Comparison of 8086 & 8088, Basic configurations of 8086/8088, Min. Mode, Max. Mode & System timing, Introduction to Instruction Set of 8086.

Practical:

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers.
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
3. To perform multiplication and division of two 8-bit numbers using 8085.
4. To find the largest and smallest number in an array of data using 8085 instructions set. Interfacing
5. To write a program to arrange an array of data in ascending and descending order.
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8085 instructions set.
7. To write a program to initiate 8251 and to check the transmission and reception of character.
8. To interface 8253 programmable interval timers to 8085 and verify the operation of 8253 in six different modes.
9. To interface a 7 segment LED with 8085.
10. To interface a stepper motor with 8085.
11. To interface a DAC with 8085.
12. To interface a ADC with 8085.

Text books:

1. R.S. Gaonkar, Microprocessor Architecture, Programming & Applications with the 8085/8080A, 5th Ed., Prentice Hall, 2002.
2. A.H. Mukhopadhyay, Microprocessor, Microcomputer and Their Applications, 3rd Edition Alpha Science International, Ltd.
3. M. Rafiquzzman: Microprocessors: Theory & Applications (Intel & Motorola), PHI.
4. Berry .B. Bray INTEL 8086/88, 80186, 286, 386, 486, Pentium Pro & Pentium IV.
5. D. V. Hall , Microprocessor and Interfacing', 3rd Edition, TMH.

Open Elective Courses offered by ECE department III-year students

EC340	Communication Systems	PCC	3-0-0	3 Credits

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design trade-offs and performance of communications systems.

Course Articulation Matrix:

PO/PSO \ CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	-	-	-	S	M	-	-	-	-	-	S
CO2	-	S	-	-	S	M	-	-	M	-	-	S
CO3	M	-	-	-	S	-	-	-	-	-	-	S
CO4	-	-	-	-	-	S	-	-	M	L	-	S

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Signal Analysis: Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise in phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM, FM, PCM and DM.

Text books:

1. S. Haykin, Communication Systems, Fourth Edition, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3 rd Edn, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, Sixth Edition, Pearson Education inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, Fourth Edition, MGH, New York, 2002.

EC390	Fundamentals of Statistical Learning	PCC	3-0-0	3 Credits

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design trade-offs and performance of communications systems.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	-	-	-	S	M	-	-	-	-	-	S
CO2	-	S	-	-	S	M	-	-	M	-	-	S
CO3	M	-	-	-	S	-	-	-	-	-	-	S
CO4	-	-	-	-	-	S	-	-	M	L	-	S

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus:

Supervised learning: Definitions, issues with overfitting and underfitting, linear methods for regression, regularization / ridge regression, model assessment and selection, Bayesian learning, linear methods for classification: linear discriminant analysis, probabilistic generative and discriminative models, Bayesian logistic regression

Kernel Methods: 1-dimensional kernel smoothers, local regression, kernel density estimation and classification, radial basis function networks, SVM, multiclass SVMs, Mixture models for density estimation and classification

Unsupervised learning: Cluster analysis; K-means clustering, combinatorial algorithms, self-organizing maps, mixtures of Gaussians, Principal component analysis: probabilistic PCA, Kernel PCA.

Text Books:

1. Trevor Hastie, et al, “The elements of statistical learning”
2. Christopher M. Bhishop, “Pattern recognition and machine learning".

Syllabus of Minor in

Artificial Intelligence for Signal Processing Applications

ECM251	**Statistical Foundations for Signal Processing and Machine Learning**	**4–0–0**	**4 Credits**

Course Outcomes: After completion of the course student will be able to:

CO1	Gain the fundamental knowledge on Random Variable, Random Processes, Matrix operations
CO2	Understand different detection and estimation methods
CO3	Link the statistical theory with machine learning
CO4	Learn Bayesian learning with statistical framework

Detailed Syllabus:

Probability Concepts
Introduction to Subject, Axioms of Probability, Probability Space, Conditional Probability, Bays Theorem, Repeated Trails, Bernoulli's Trails. Concept of a Random Variable, Continuous and discrete random variables, Distribution and density functions with its properties, Functions of one random variable. Concept of Random Process and its Statistical properties.

Linear Algebra
Vectors, Vector Spaces, Matrices and its properties, Quadratic Forms and Positive Semidefinite Matrices, Eigen values and Eigen Vectors

Detection Theory
Hypothesis testing: Binary hypothesis testing, MAP criteria, Bayes risk, Neyman-Pearson theorem, Multiple hypothesis testing. Detection of known signals in noise, Matched filter.

Estimation Theory
Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems. Properties of estimators, Minimum variance unbiased estimation, Cramer-Rao lower bound. Parameter estimation: Bayes estimation, MAP, ML estimators.

Evaluating hypotheses
Estimating hypotheses accuracy, Basics of sampling theory, A general approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms.

Bayesian learning
Bayes theorem and concept learning, Maximum likelihood and least squared error hypotheses, Maximum likelihood hypotheses for predicting probabilities, Minimum description length principle, Bayes optimal classifier, Gibb's algorithm, Naive bayes classifier, Bayesian belief networks, The EM algorithm.

TEXT BOOKS:

[1] A.Papoulis and S.Unnikrishna Pillai, "Probability, Random Variables and stochastic processes, 4ed. The McGraw-Hill 2002.
[2] Harry L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, Inc. 2001.
[3] Steven M.kay, "Fundamentals of Statistical signal processing, volume-1: Estimation theory". Prentice Hall 1993.
[4] Steven M.kay, "Fundamentals of Statistical signal processing, volume-2: Detection theory". Prentice Hall 1993.

REFERENCE BOOKS:

[1] Thomas A.Schonhoff and Arthur A. Giordano, “Detection and estimation theory and its applications”, Pearson-Prentice Hall.
[2] Tom M. Mitchell, “Machine Learning” McGraw-Hill Science/Engineering/Math; (March 1, 1997).
[3] M. Hayes, Statistical Digital Signal Processing and Modeling, Wiley, 1996.

ECM301	Nonlinear Programming	3–0–0	3 Credits

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Able to formulate mathematical models of real-world problems
CO2	Understand the major limitations and capabilities of deterministic operations
CO3	Handle, Solve and analyse problems using nonlinear programming and other mathematical programming algorithms
CO4	Solve various multivariable optimization problems

Detailed Syllabus

Part – I : Theory
Standard form of optimization problems. Classification of optimization problems. Optimality conditions for unconstrained optimization problems: First order and second order necessary conditions.
Convex sets and functions, properties of convex functions, global optimality of convex optimization problems, optimality conditions for convex optimization problem. Theory of Lagrange multipliers, Karush-Kuhn-Tucker optimality conditions for constrained optimization problems, Duality: The dual problem, weak duality theorem.

Part – II: Algorithms

Gradient methods for unconstrained optimization problems, Newton's method, Nonderivative methods. Lagrange multiplier methods for constrained optimization problems: Barrier and Interior point methods, Penalty and augmented Lagrangian methods.

Global optimization methods: Genetic algorithms, evolutionary algorithms, and particle swarm optimization.

TEXTBOOKS:

1. Nonlinear Programming, Dimitri Bertsekas, Athena Scientific Press, Second edition, 1999.
2. Nonlinear Programming: Theory and Algorithms, Bazaraa, Mokhtar S., Hanif D. Sherali, and C. M. Shetty, New York: John Wiley & Sons, 1993.
3. An Introduction to Genetic Algorithms, Milani Mitchel, MIT Press, 1998.

REFERENCE BOOKS:

1. A. E. Eiben, and J. E. Smith, Introduction to Evolutionary Computing, Springer, 2010.

ECM351	Machine Learning for Signal Processing Applications	4–0–0	4 Credits

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Understanding of the fundamentals of machine learning (ML) techniques useful for various signal processing applications
CO2	Understanding of various mathematical methods involved in ML
CO3	Design various machine learning models for the problems (in signal processing) at hand and optimize them efficiently

Detailed Syllabus:

Review of Linear algebra / Matrix theory

Machine learning basics: Supervised and unsupervised learning, classification and regression (linear models), evaluation metrics, probability models and expectation maximization algorithm. Gaussian and mixture Gaussian models

Discriminative modeling: Neural networks, support vector machines, and back propagation, convolutional and recurrent neural networks.

Machine learning for Audio classification: Time series analysis, LSTMs, and CNNs,

Machine learning for Image processing: Transfer learning, Attention models, Attribute based learning.

Machine learning for Communications: Applications in modulation classification, adaptive modulation for wireless systems

TEXT BOOKS:

1. Pattern Recognition and Machine Learning, C. M. Bishop, Second Edition, Springer, 2011,
2. Fundamentals of Speech Recognition, L. Rabiner, and H Juang, Printice Hall, 1993,
3. Deep Learning, I. Goodfellow, Y. Bengio, A. Courville, MIT Press, 2016.
4. Selected Conference / Journal papers such as IEEE Transactions on Wireless Communications, ICASSP, etc.

ECM401	Digital Modulation and Coding	3–0–0	3 Credits

Prerequisites: None

Course Outcomes: After completion of the course student will be able to:

CO1	Apply the knowledge of statistical theory of communication and explain the conventional digital communication system.
CO2	Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise
CO3	Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.
CO4	Describe and analyze the digital communication system with spread spectrum modulation

Detailed Syllabus:

Model of digital communication system. Geometrical interpretation of signals-numerical examples, Detection of known signals in noise, Union bound on probability of error, Correlation receiver, Matched filter receiver, numerical examples. Detection of signals with unknown phase in noise.

Digital modulation formats-coherent binary modulation techniques, Coherent quadrature modulation techniques Coherent quadrature modulation techniques, Noncoherent binary modulation techniques

Digital modulation techniques – binary ASK, FSK, and PSK. Signal space diagram. Error probabilities.

M-ary PSK, FSK, QAM, MSK and GMSK. Optimum detector. Signal constellation, error probability. Linear block codes, Encoding and decoding. Cyclic codes. Convolutional codes. Viterbi decoding. TCM.

Spread spectrum (SS) techniques; direct S.S and frequency hop S.S. Processing gain and jamming margin. CDMA.

TEXTBOOKS:

1. J.G. Proakis, Digital Communication (4/e), McGraw – Hill,2001.
2. S. Haykin, Communication Systems (4/e), Wiley,2001.

REFERENCE BOOKS:

1. B. Sklar, Digital Communications: Fundamentals & Applications, Pearson Education, (2/e), 2001.
2. A.B. Carlson : Communication Systems, 3/e McGraw Hill.
3. R.E. Zimer & R.L. Peterson: Introduction to Digital Communication, PHI, 2001.

EC402	Artificial Intelligence for Signal Processing Applications Lab	0–0–3	2 Credits

Course Outcomes: After completion of the course student will be able to:

CO1	To Understand the basic concepts of python programming
CO2	Able to understand the concept and implementation of neural networks.
CO3	Application of AI to signal processing and communication applications.

List of Experiments:

1. Introduction to Python
2. Implementation of a neural network in python and MATLAB programming.
3. RNN based Speech recognition system
4. Deep Learning based Image enhancement
5. RNN based estimating the parameters of a wireless channel.
6. RNN based resource allocation for a wireless network.

Syllabus of B. Tech with Honors

Courses for Honors							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Offered sem**
1	ECH301	Wireless Communication	3	1	0	**04**	**5th**
2	ECH302	Detection and Estimation Theory	3	1	0	**04**	**5th**
3	ECH351	Advanced Signal Processing for Image and Video	3	1	0	**04**	**6th**
4		Course IV: MOOCs	3	1	0	**04**	**6th**
5		Course V: MOOCs	3	1	0	**04**	**7th**
		TOTAL	**15**	**5**	**0**	**20**	

ECH301	**Wireless Communication**	**3–1–0**	**4 Credits**

CO1	Understand the evolution of cellular communication systems up to and beyond 3G
CO2	Design a cellular link and estimate the power budget.
CO3	Choose proper multiple accessing methods depending on channel model
CO4	Identify traffic channels for call processing

CO5	Calculate key performance metrics of a cellular communication system.

Course Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	L	M	M	-	-	-	-	-	M	-
CO2	M	-	-	-	M	M	L	-	-	-	-	M	M	M
CO3	M	-	-	-	M	M	L	-	-	-	-	-	M	M
CO4	L	-	-	-	M	-	L	-	-	-	-	-	M	M
CO5	M	-	-	-	S	M	M	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation

Detailed Syllabus: -

Introduction Evolution of wireless communication systems, Examples of wireless communication systems. The cellular concept – system design fundamentals Concept of frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and grade of service, Improving coverage and capacity in cellular systems.

The cellular concept – system design fundamentals Concept of frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and grade of service, Improving coverage and capacity in cellular systems.

Propagation models Free space propagation model, Two-ray ground reflection model, Distance power loss, Macro-cell propagation model, Micro-cell propagation model, Shadowing model, Multipath effects in mobile communication, Models for multipath reception.

Equalization, diversity and channel coding Fundamentals of equalization, Adaptive equalizers, Linear and nonlinear equalization, Algorithms for adaptive equalization, Diversity techniques, Fundamentals of channel coding, Overview of error detection and correction codes.

Multiple access techniques Introduction to multiple access, Frequency division multiple access, Time division multiple access, spread spectrum multiple access, Space division multiple access, Packet radio, Orthogonal frequency division multiple access;

Introduction to wireless systems and standards.

Textbooks:

1. William C Y Lee, "Mobile Cellular Telecommunications, McGraw Hill. (Main Book)
2. Stallings, *Wireless Communications and Networks*, 1st Ed., Prentice Hall, 2015.
3. Schwartz, *Mobile Wireless Communications*, Cambridge University Press. (Main Book)
4. Theodore S Rappaport, "Wireless Communications Principles and Practice", 2nd Ed., Prentice Hall, 2002.
5. Xiang, Wei, Kan Zheng, and Xuemin Sherman Shen, eds. *5G mobile communications*. Springer, 2016.

ECH301	Wireless Communication	3–1–0	4 Credits

CO1	Understand the evolution of cellular communication systems upto and beyond 3G
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CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	L	M	M	-	-	-	-	-	M	-
CO2	M	-	-	-	M	M	L	-	-	-	-	M	M	M
CO3	M	-	-	-	M	M	L	-	-	-	-	-	M	M
CO4	L	-	-	-	M	-	L	-	-	-	-	-	M	M
CO5	M	-	-	-	S	M	M	-	-	-	-	M	M	M

S: Strong correlation, M: Medium correlation, L: Low correlation