Proceedings of Board of Studies Meeting
(Held on February 13, 2023)

Syllabus for the programs:

Bachelor of Technology in Electronics Engineering

(As per the Ordinances for Bachelor of Technology as per Academic Council)

Submitted By

Department of Electronics Engineering,

Harcourt Butler Technical University,

Nawabganj, Kanpur-208002 (UP)

Contents

Rajani Bisht Jakhtar

Vishal Khare

Vision, Mission and Program Educational Objectives

VISION AND MISSION OF THE DEPARTMENT

Vision

Department of Electronics Engineering aims to deliver Technical Education in the field of Electronics and Communication Engineering, for producing Engineers and Technologists who are happy, healthy and competent professionals, motivated to serve the society through research & innovation.

Mission

1. To educate and train the students with state-of-the-art in Electronics and Communication Engineering.
2. To prepare the students who are fit for meeting the requirements and challenges of the Industry right at the time of their graduation by evolving a sustainable Industry-University interaction system for this.
3. To upgrade the teaching standards through continued efforts toward improvement of the qualification and expertise of the teachers as well as supporting staff.
4. To create awareness amongst the students towards socio environmental technologies by offering related courses and organizing seminars/workshops on these topics in the university and by encouraging participation in similar activities at other places.
5. To expand research and development activities in the frontier areas related to Electronics and Communication.
6. To include the aspect of integration of environmental balance and human values in the curriculum.
7. To provide academic support to other technical institutions at state & national level through the process of networking.
8. To start social service programs like education for masses, particularly using the enhanced means of communication.

Rajani Bisht

Vishal Khare

VISION AND MISSION OF THE UNIVERSITY

VISION

"To achieve excellence in technical education, research and innovation".

MISSION

1. Imparting Knowledge to develop analytical ability in science and technology to serve the industry and society at large.
2. Equip and enable students with conceptual, technical and managerial skills to transform the organization and society.
3. Inculcating entrepreneurial philosophy and innovative thinking to promote research, consultancy and institutional social responsibility.
4. Serving people, society and nation with utmost professionalism, values and ethics to make development sustainable and quality of life.

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Vishal Khare

Program Educational Objectives (PEOs)

Program graduates, within three years from their graduation will

PEO 1: have knowledge of basic and applied sciences, so as to apply the necessary competence for technically sound, economically feasible and socially acceptable solutions of real life complex engineering problems.

PEO 2: be fit for meeting the requirements and challenges of industries, research and academic institutions both at the national and International level, by applying expertise gained in area of electronics and communication engineering.

PEO 3: be professionally competent with excellent communication and management skills along with being enterprising professionals and responsible citizens capable of delivering their services individually as well as in a collaborative framework.

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Structure of the Curriculum

Semester Wise Course Structure & Evaluation Scheme

For B.Tech. in Electronics Engineering

(Effective from Session 2022-2023 for new entrants)

BSC: Basic Science Course
OEC : Open Elective Course

ESC: Engineering Science Course
PCC: Program Core Course

PEC: Program Elective Course
HSMC: Hum., Social Sc. and Management Courses

I Semester

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Chemistry	NCY	4	3	0	2	15	20	15	50	50	**100**
2	ESC	Introduction to Computer Science &Engineering	NCS	4	3	1	0	30	20	-	50	50	**100**
3	ESC	Introduction to Electronics Engineering	NET 101	4	3	1	0	30	20	-	50	50	**100**
4	ESC	Introduction to Civil Engineering	NCE	4	3	1	0	30	20	-	50	50	**100**
5	ESC	Introduction to Chemical Engineering& Chemical Technology	NCH	4	3	1	0	30	20	-	50	50	**100**
6	ESC	Workshop Practice	NWS	2	0	0	4	-	20	30	50	50	**100**
	Total Credits: 22												**600**

***** NET 102: Introduction to Electronics Engineering (Even Sem)

II Semester

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engineering Physics	NPH	4	3	0	2	15	20	15	50	50	**100**
2	BSC	Engineering Mathematics-I	NMA	4	3	1	0	30	20	-	50	50	**100**
3	ESC	Introduction to Electrical Engineering	NEE	4	3	0	2	15	20	15	50	50	**100**
4	ESC	Introduction to Mechanical Engineering	NME	4	3	1	0	30	20	-	50	50	**100**
5	HSMC	Professional Communication	NHS	4	2	1	2	15	20	15	50	50	**100**
6	ESC	Engineering Graphics	NCE	2	0	0	4	30	20	-	50	50	**100**
	Total Credits: 22												**600**

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III Semester

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engg. Math-II	NMA	4	3	1	0	30	20	0	50	50	100
2	ESC	Electrical Circuit Analysis	NEE	5	3	1	2	15	20	15	50	50	100
3	PCC	Electrical Measurement and Measuring Instruments	NEE	4	3	1	0	30	20	0	50	50	100
4	PCC	Solid State Devices and Circuits *	NET 201	4	3	0	2	15	20	15	50	50	100
5	PCC	Digital Electronics	NET 203	4	3	0	2	15	20	15	50	50	100
6	PCC	Hardware Description Language	NET 205	3	2	0	2	15	20	15	50	50	100
	Total Credits: 24												**600**

NET 207: Digital Electronics (CS & IT) and NET 209: Solid State Devices and Circuits (EE)

IV Semester

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	BSC	Engg. Maths-III	NMA	4	3	1	0	30	20	0	50	50	100
2	ESC	Data Structure Using C	NCS	4	2	1	2	15	20	15	50	50	100
3	PCC	Electro Magnetic Field Theory	NET 202	4	3	1	0	30	20	0	50	50	100
4	PCC	Signals & Systems *	NET 204	5	3	1	2	15	20	15	50	50	100
5	PCC	Analog Circuits	NET 206	4	3	0	2	15	20	15	50	50	100
6	HSMC	Engg. Economics & Management	NHS	3	3	0	0	30	20	0	50	50	100
	Total Credits: 24												**600**

*NPTEL Courses

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V - Semester

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PCC	Antenna and Wave Propagation	NET 301	4	3	1	0	30	20	0	50	50	100
2	PCC	Analog Communication*	NET 303	4	3	0	2	15	20	15	50	50	100
3	PCC	Linear System Theory (Control Systems)	NET 305	4	3	1	0	30	20	0	50	50	100
4	PCC	Microprocessors and Microcontrollers	NET 307	4	3	0	2	15	20	15	50	50	100
5	PCC	VLSI Technology	NET 309	4	3	1	0	30	20	0	50	50	100
6	OEC-I	Open Elective-I	OET	2	2	0	0	30	20	0	50	50	100
	Total Credits: 22												**600**

VI -Semester

S. No.	Course Type	Course Title	Subject Code*	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PCC	Analog Integrated Circuit	NET 302	4	3	0	2	15	20	15	50	50	100
2	PCC	Digital Communication*	NET 304	4	3	1	0	30	20	0	50	50	100
3	PCC	VLSI Design*	NET 306	5	3	1	2	15	20	15	50	50	100
4	PCC	Digital Signal Processing*	NET 308	4	3	0	2	15	20	15	50	50	100
5	PEC-I	PEC -I	NET	3	3	0	0	30	20	0	50	50	100
6	HSMC	Entrepreneurship Development	NHS	2	2	0	0	30	20	-	50	50	100
	Total Credits: 22												**600**

*NPTEL Courses

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VII-Semester

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-II	PEC-II	NET	4	3	1	0	30	20	0	50	50	100
2	PEC-III	PEC -III	NET	3	3	0	0	30	20	0	50	50	100
3	PEC-IV	PEC -IV	NET	3	3	0	0	30	20	0	50	50	100
4		Seminar	NET 471	2	0	0	4	0	50	0	50	50	100
5		Industrial Training	NET 481	2	0	0	4	0	50	0	50	50	100
6		Minor Project	NET 491	6	0	0	12	0	50	0	50	50	100
7	OEC-II	Open Elective-II	OET	2	2	0	0	30	20	0	50	50	100
	Total Credits: 22												**700**

VIII -Semester

S. No.	Course Type	Course Title	Subject Code	Credits	Periods			Sessional Marks				ESE	Total Marks
					L	T	P	MSE	TA	Lab	Total		
1	PEC-V	PEC -V	NET	4	3	1	0	30	20	0	50	50	100
2	OEC-III	Open Elective-III	OET	2	2	0	0	30	20	0	50	50	100
3		Project	NET 492	16	0	0	32	0	50	0	200	200	400
	Total Credits: 22												**600**

Note: Internal Evaluation of Project in VII semester will be conducted by the Departmental Committee. Evaluation of project in VIII semester will be conducted by External and Internal Examiners.

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ELECTIVE-I

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	PEC-I	NET 322	DSD using VHDL	3(3-0-0)	30	20	-	50	50	100
2.	PEC-I	NET 324	Filter Design and Analysis	3(3-0-0)	30	20	-	50	50	100
3.	PEC-I	NET 326	Microwave and Radar Engineering	3(3-0-0)	30	20	-	50	50	100
4.	PEC-I	NET 328	Data Communication Network	3(3-0-0)	30	20	-	50	50	100
5.	PEC-I	NET 330	Advanced Semiconductor Devices (ASD)	3(3-0-0)	30	20	-	50	50	50

ELECTIVE-II

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	PEC-II	NET 421	Semiconductor Device Modelling	4(3-1-0)	30	20	-	50	50	100
2.	PEC-II	NET 423	Image Processing	4(3-1-0)	30	20	-	50	50	100
3.	PEC-II	NET 425	Optical Communication	4(3-1-0)	30	20	-	50	50	100
4.	PEC-II	NET 427	Opto-Electronics	4(3-1-0)	30	20	-	50	50	100

ELECTIVE-III

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	PEC-III	NET 441	Embedded Systems	3(2-0-2)	15	20	15	50	50	100
2.	PEC-III	NET 443	VLSI Device verification &Testing	3(3-0-0)	30	20	-	50	50	100
3.	PEC-III	NET 445	Biomedical Signal Processing	3(2-0-2)	15	20	15	50	50	100
4.	PEC-III	NET 447	Wireless Communication	3(3-0-0)	30	20	-	50	50	100
5.	PEC-III	NET 449	Radio Frequency Integrated Circuit	3(3-0-0)	30	20	-	50	50	100

ELECTIVE-IV

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	PEC-IV	NET 461	SoC Design	3(3-0-0)	30	20	-	50	50	100
2.	PEC-IV	NET 463	Adaptive Systems	3(3-0-0)	30	20	-	50	50	100
3.	PEC-IV	NET 465	Satellite Communication	3(3-0-0)	30	20	-	50	50	100
4.	PEC-IV	NET 467	Photo-Voltaic Cell	3(3-0-0)	30	20	-	50	50	100
5.	PEC-IV	NET 469	Sensor technology	3(3-0-0)	30	20	-	50	50	100

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ELECTIVE-V

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	PEC-V	NET 422	VLSI Implementation of DSP Algorithms	4(3-1-0)	30	20	-	50	50	100
2.	PEC-V	NET 424	Network Science	4(3-1-0)	30	20	-	50	50	100
3.	PEC-V	NET 426	Micro Electronic Mechanical Systems (MEMS)	4(3-1-0)	30	20	-	50	50	100

List of Open Electives

	OEC-I	OEC-II	OEC-III
1.	Human Values	Soft Computing	Robotics
2.	Cyber Security	Artificial Intelligence	Data Sciences
3.	Indian Knowledge Tradition	3-D Printing	Machine Learning
4.	Environment & Ecology	Logistics & Supply Chain Management	Sustainable Development
5.	One Course Offered by each degree awarding departments	One Course Offered by each degree awarding departments	One Course Offered by each degree awarding departments
6.	One Course Offered by School of Basic & Applied Sciences	One Course Offered by School of Basic & Applied Sciences	One Course Offered by School of Basic & Applied Sciences
7.	One Course Offered by School of Humanities & Social Sciences	One Course Offered by School of Humanities & Social Sciences	One Course Offered by School of Humanities & Social Sciences

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List of Open Elective Courses offered by Electronics Department

OPEN ELECTIVE-I

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	OEC-I	OET 301	Analog Circuits	2(2-0-0)	30	20	-	50	50	100
2.	OEC-I	OET 303	System Design using MATLAB	2(2-0-0)	30	20	-	50	50	100
3.	OEC-I	OET 305	Semiconductor Devices	2(2-0-0)	30	20	-	50	50	100

OPEN ELECTIVE-II

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	OEC-II	OET 401	VLSI Technology	2(2-0-0)	30	20	-	50	50	100
2.	OEC-II	OET 403	Communication Systems	2(2-0-0)	30	20	-	50	50	100
3.	OEC-II	OET 405	Integrated Circuits	2(2-0-0)	30	20	-	50	50	100

OPEN ELECTIVE-III

SI.NO.	Course Type	Subject Code	Course Title	Credits(LTP)	Sessional Marks				ESE	Total Marks
					MSE	TA	Lab	Total		
1.	OEC-III	OET 402	Satellite Communication	2(2-0-0)	30	20	-	50	50	100
2.	OEC-III	OET 404	Mobile Communication	2(2-0-0)	30	20	-	50	50	100
3.	OEC-III	OET 406	Network Science	2(2-0-0)	30	20	-	50	50	100

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The components of the curriculum

Table (a) Program curriculum grouping based on course components

Course Component	**Curriculum Content (% of total Credits of the program)**	**Total number of credits**
Basic Sciences (BSC)	11.11	20
Engineering Sciences(ESC)	20.55	37
Humanities and Social Sciences (HSMC)	5	9
Program Core (PCC)	36.11	65
Program Electives (PEC)	9.44	17
Open Electives (OEC)	3.33	6
Project(s)	12.22	22
Industrial training and Seminars	2.22	2+2=4
Total		**180**

Table (b) Program curriculum grouping based on course components as per semester: **Frequency & Credits**

Sem	**BSC**		**ESC**		**HSMC**		**PCC**		**PEC**		**OEC**		**Project**		**Ind. training**		**Seminar**		**Total**
	Credits	No.	Credits	No.	Credits	No.		No.	Credits	No.	Credits	No.	Credit	No.	Credit	No.	Credit	No.	Credit
I	4	1	4*4 +2=18	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
II	4+4=8	2	4+4+2=10	3	4	1	-	-	-	-	-	-	-	-	-	-	-	-	22
III	4	1	5	1	-	-	4+4+4+3=15	4	-	-	-	-	-	-	-	-	-	-	24
IV	4	1	4	1	3	1	4+5+4=13	3	-	-	-	-	-	-	-	-	-	-	24
V	-	-	-	-	-	-	4+4+4+4+4=20	5	-	-	2	1	-	-	-	-	-	-	22
VI	-	-	-	-	2	1	4+4+5+4=17	4	3	1	-	-	-	-	-	-	-	-	22
VII	-	-	-	-	-	-	-	-	10	3	2	1	6	1	2	1	2	1	22
VIII	-	-	-	-	-	-	-	-	4	1	2	1	16	1	-	-	-	-	22
Tot	**20**	**5**	**37**	**10**	**9**	**3**	**65**	**16**	**17**	**5**	**6**	**3**	**22**	**2**	**2**	**1**	**2**	**1**	**180**

Vishal Khare

1st Year

ESC (NET 101/102)	**Introduction to Electronics Engineering**	**3L:1T:0P**	**4 credits**

Unit-I: P-N Junction Diode, Depletion layer, Barrier potential, forward and reverse bias, Knee voltage, V-I Characteristics and its Equivalent Models, Avalanche and Zener Break Down, Diode Applications as Half Wave, Full Wave & Bridge Rectifier and their comparative analysis, Clippers, Clampers, Voltage Multiplier Circuit, Zener Diode and its Applications as a voltage regulator, Varactor diode.

Unit-II: Basic theory and operation of PNP and NPN transistors, Characteristics of Common Base, Common Emitter and Common Collector configuration, DC Biasing : Fixed Bias, Emitter Bias, voltage divider bias, Field effect transistor: JFET, Drain and Transfer characteristic, MOSFET, Introduction to Operational Amplifier and its Applications as Adder, Subtractor, Integrator, Differentiator, log antilog.

Unit-III: Number System, Base Conversion, BCD code, Excess-3 code, Gray Code, Review of Logic Gates, Concept of Universal Gates &, Boolean laws and theorems, SOP and POS representation of Boolean functions, Minimization of Boolean functions using K map,
Basic Combinational Circuits: Half Adder, Full Adder, Subtractor, Sequential Circuits: Latch, Flip-Flops, Characteristic and Excitation Table of SR, JK, D and T Flip-flop. Concept of Master Slave Flip- Flop, Shift Registers.

Unit-IV: Functional Elements of Instruments, Classification & Characteristics, Types of
Errors, Sources of Error, Dynamic Characteristics, Active and Passive Transducers: Resistive Transducers, Thermistor, Strain Gauge, Thermocouple, Differential Output Transducers, LVDT and their Characteristics.

Unit-V: Display Devices: LCD, LED, Seven Segment Display, Alphanumeric Display, Electronic Ammeter and Voltmeter, Digital Multi-meter, Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscope (DSO)

Text Books:
1. Boylestad, Robert &Nashelsky, Louis "*Electronic Devices & Circuit Theory*" 11th Ed. Pearson Education India, 2015.
2. H.S. Kalsi "*Electronic Instrumentation*" 3rd Ed. McGraw Hill Education, 2017.
3. Malvino, Leach, Goutam Saha "*Digital Principles & Applications*" 7th Ed. McGraw Education, 2010.

Reference Books:
1. Sedra, Adel S., Smith, Kenneth C. "*Microelectronic Circuits*"5th Ed. Oxford University Press, 2012.
2. Sawhney A.K "*Electrical and electronic Measurement and Instrumentation*" Dhanpat Rai & Co(P) Ltd 2015.
3. Behzad Razavi "*Fundamentals of Microelectronics*"2ndEd. Wiley, 2017.
4. Malvino, A.P., Bates.D.J, Hoppe P.E "*Electronics Principles*" 9th Ed. McGraw-Hill, 2021.
5. Lectures of NPTEL

OUTCOMES:
Upon Completion of the course the students will be able:
1. To understand the basic concept of diodes, and use the diode as a circuit element for different applications.
2. To understand the working of BJT, FET, OP-amp and their application.
3. To design the simple digital circuits using different logic gates.
4. To identify the errors while making electronic measurements and to understand the working of different types of transducers.
5. To understand the working principle of electronic instruments and displaying it on electronic devices.

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2nd Year

PCC (NET 201)	Solid State Devices and Circuits	3L:0T:2P	4 credits

Solid State Physics& Diode: Properties of semiconductor, Energy bands in intrinsic and extrinsic semiconductor; effect of doping on Fermi potential, diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; **C**ontact potential.

P-N Junction Diode, Depletion Region, I-V Characteristics, and Equation, Transition Capacitance, Diffusion Capacitance,Junction Breakdown Diodes. Application: Rectifier, clipper, clamper circuits and analysis.

BJT & MOSFET: Bipolar Junction Transistor: Transistor switching characteristics, breakdown in Transistors, Ebers-Moll transistor equations, Analysis of transistor cutoff and saturation regions, small signal low frequency transistor hybrid model, simplified hybrid model and high frequency response, high frequency model of a transistor-hybrid pi model.

JFET & MOSFET: Review of device structure operation and V-I characteristics. MOSFET as an Amplifier and switch, Biasing of MOSFET amplifier circuits, small-signal operation and models, single stage MOSFET amplifier, CS, CD and CG amplifiers,

Feedback amplifiers: Classification of amplifiers, Concept of feedback, transfer gain with feedback, General characteristics of negative feedback amplifiers, Effect of feedback on amplifier characteristics, Method of analysis of a feedback amplifier, Voltage-Series feedback, Current-Series feedback, Current-Shunt feedback, Voltage-Shunt feedback.

Oscillators: Basic principles of sinusoidal oscillators, Phase Shift oscillators, Resonant-Circuit oscillators, General form of an oscillator circuit (Hartley and Colpitts oscillators), Wien-bridge oscillator, Crystal oscillators, Frequency Stability.

Power amplifiers: Classification of power amplifiers, class A, AB, B and C power amplifiers and their efficiency, push-pull and complimentary Symmetry amplifiers.

LIST OF EXPERIMENTS:

Note: At least 08 experiments are to be performed from the following.

1.Familiarization of electronic components (Resistor, Capacitor, diode, BJT, MOSFET, JFET), Familiarizationof laboratory instruments (Function generator, DC power supply, CRO, DSO).
2.To verify the PN Junction Diode characteristics
3. Design and implement a voltage regulator circuit using zener diode
4. Implement Half wave, full wave (centre tap & Bridge) Rectifier with and without input capacitor filter.
5. Design and implement Clipper and clamper circuits
6.To verify the I/P and O/P characteristics of BJT in CE configuration
7.To verify the I/P and O/P characteristics of MOSFET in CS configuration
8. Design and implement wein bridge oscillator using op-amp.
9. Design and implement feedback amplifier.
10. Calculate the α, β and γ of CB, CE and CC BJT.

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Text Books

1. Streetman, B.G. & Banerjee, Sanjay "*Solid State Electronic Devices*" Prentice Hall (India) 2014.
2. Boylestad, Robert &Nashelsky, Louis "*Electronic Devices & Circuit Theory*" 11^{th} Ed.Pearson Education India, 2015.
3. Sedra, Adel S., Smith, Kenneth C. "*Microelectronic Circuits*" 5^{th}Ed. Oxford University Press, 2012.
4. Millman, J. and Grabel, A. "*Microelectronics*" 2^{nd} Ed. McGraw Hill Education, 2017.

Reference Books:

1. Bell, David A. "*Electronic Devices & Circuits*" OUP India (Anna edition) 2010.
2. Nair, B. Somanathan "*Electronic Devices & Applications*" 1^{st} Ed. PHI Learning, 2006
3. Nagrath, I. J. "*Electronics, Analog & Digital*"New Title Ed. PHI Learning ,1998
4. Neamen, Donald A. "*Electronic circuits-Analysis & Design*", 3^{rd}Ed. McGraw Hill education, 2006.
5. Neamen, Donald A. "*Semiconductor Physics & Devices*" 4^{th} Ed. McGraw Hill education, 2017.
6. Salivahanan, S. & Kumar, Suresh N. &Vallavraj / "*Electronic Devices & Circuits*" 3^{rd} Ed. McGraw Hill education, 2012.
7. Schaum's Outlines "*Electronic Devices & Circuits*"/ McGraw Hill Education , 2^{nd} edi.2002.
8. Millman , J., Halkias, C.& Parikh, C.D "*Integrated Electronics*"2^{nd} Ed.McGraw Hill Education, 2017.
9. Lectures of NPTEL, Razavi.

Course Outcome:

1. Concepts of the basic psychical concept of band formation, Fermi potential and all reverent physics knowledge to understand the operation of semiconductor devices and working of diode
2. Understanding & Numerical solutions on working of BJT and MOSFET
3. Analyze the concept of feedback and different amplifiers in mid-band and high frequency region.
4. Analyze the principle and working of oscillator.
5. Understand the concept of power amplifier.

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PCC (NET 203)	**Digital Electronics**	**3L:0T:2P**	**4 credits**

Number System: Quantization and implementation of digital number system, Binary Numbers, Number base conversion, Data representations and arithmetic using Floating point & fixed point number system: Signed, Unsigned, Fractional & Integer representation, Complements, Binary coded decimal, Gray Code, Excess-3 code, Boolean laws and Postulates, SoP and PoS representation, Minimization using K-Map (upto 6 variables), don't care condition, Implementation of Boolean function using basic and universal gates.

Combinational Circuits: Design procedure, Half adder, Full adder, Half subtractor, Full subtractor, Ripple binary adder, binary adder/subtractor, Carry Look Ahead adder, BCD adder, Binary Multiplier, Binary Divider, Magnitude Comparator, parity checker, parity generators, code converters, Multiplexer, Demultiplexer, decoder, encoder, priority encoder.

Sequential Circuits: Latches, Flip-flops - SR, JK, D, T, Characteristic table and equation, Excitation table, Level Triggering & Edge triggering, Concept of Master-Slave, Design of sequential circuits, Synchronous and Asynchronous circuits, Asynchronous Ripple counter, Up/Down counter, Modulo–n counter, Design of Synchronous counters: state diagram, State assignment, State table, State reduction, Excitation table and maps-Circuit implementation, Programmable counters, Realization of one flip flop using other flip flops, Registers – shift registers, Universal shift registers, Ring counter, Johnson counter, Sequence generators.

Memory Devices: Classification of memories, ROM organization, PROM, EPROM, EEPROM, EAPROM, RAM – RAM organization, Write operation & Read operation, Memory cycle, Timing wave forms, Memory decoding, memory expansion, Static RAM Cell, Bipolar RAM cell, MOSFET RAM cell, Dynamic RAM cell, Programmable Logic Devices, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field Programmable Gate Arrays (FPGA), Implementation of combinational logic circuits using ROM, PLA, PAL, Implementation of state machine using Multiplexers and programmable logic devices.

Logic Families: Bipolar Logic: Diode Logic, Transistor Logic Inverter, TTL Logic with three types of output configurations, ECL, MOS Logic, Designing of all gates using MOS logic, CMOS Dynamic Electrical Behavior, Designing of all gates using CMOS logic.

LIST OF EXPERIMENTS:
Note: At least 08 experiments are to be performed from the following.

1. Verify the truth table of all basic and universal logic Gates using their ICs.
2. Design a circuit to implement a Boolean function using basic and universal gates ICs.
3. Design four bit and eight bit binary adder and subtractor circuit.
4. Design a circuit to implement a Boolean function using Multiplexer.
5. Design a circuit to implement a Boolean function using Decoder.
6. Design a circuit of Priority Encoder Using 74LS148 IC.
7. Seven Segment Display Experiment.
8. Design Latch and Flip flops Using logic Gates.
9. Design and Testing of Ripple Counters Using ICs.
10. Design and Testing of Mod-K Synchronous Counters.
11. Design and Testing of Shift Registers.
12. Input, Output & Transfer Characteristics of CMOS Inverter.
13. Design and simulation of NAND and NOR gate using NMOS and CMOS logic.

Rajani Bisht Jakhtani Vishal Khare

Text Book:

1. Mano, M. Morris & Michael D. Ciletti "*Digital Design: with an Introduction to Verilog HDL, VHDL and SystemVerilog*"6th Ed. Pearson India 2018.
2. Wakerly, John F. "*Digital Design: Principles & Practices*" 3rd Ed.Pearson Education

References Books:

1. Bartee, Thomas C. "*Fundamentals of Digital Computers*" McGraw-Hill education 2001
2. Gopalan, K. "Gopal" "*Introduction to Digital Microelectronic Circuits*" Indo-American books 2019.
3. Taub, Herbert & Schilling, Donald "*Digital Integrated Electronics*" McGraw- Hill Education 2017.
4. Millman, Jocob & Taub, Herbert "*Pulse, Digital and Switching Waveforms*" 3rd, McGraw-Education 2017.
5. Malvino, Leach, Goutam Saha / "Digital Principles & Applications" 7th,McGraw Education, 2010.
6. Mano, M. Morris "*Digital Logic and Computer Design*" 1stPearson Education 2004
7. Tokheim, H. Roger L. "*Digital Electronics Principles & Application*" 8thMcGraw-Hill 2013.
8. John. M Yarbrough, "*Digital Logic Applications and Design",*1st, Cengage Learning India, 2006.
9. Charles H. Roth. "*Fundamentals of Logic Design*", 7th Ed.Cengage Learning 2013.
10. Thomas L. Floyd, "*Digital Fundamentals*", 11th Ed, Pearson Education 2015.
11. Donald D. Givone, "*Digital Principles and Design*", McGraw Education2017.
12. Lectures of NPTEL

Course Outcome:

After the completion of syllabus student will be able to:

1. Analyze different methods used for simplification of Boolean expressions.
2. Design and implement Combinational circuits.
3. Design and implement synchronous and asynchronous sequential circuits.
4. Design Memory units and their application in function implementation.
5. Learn about logic families and its interfacing with real world.

Vishal Khare

Rajani Bisht Jakhtani

PCC (NET 205)	**Hardware Description Language**	**2L:0T:2P**	**3 credits**

Introduction to VHDL: What is VHDL, Programming languages Vs. HDL, Describing digital systems: behavioral, data flow, structural, Design Flow, VHDL Syntax, Number and Character Representations in VHDL

Code Structure: VHDL Libraries and Packages, Library/Package Declarations, ENTITY, ARCHITECTURE, PORT, Specifying PORT Arrays GENERIC, Introductory VHDL Examples: basic Gates & universal gates, multiplexer, decoder.

Data Types: VHDL Objects, Data-Type Libraries and Packages, Type Classifications, Standard Data Types, Standard-Logic Data Types, Unsigned and Signed Data Types, Fixed- and Floating-Point Types,

User defined data type: Predefined Data Types Summary User-Defined Scalar Types, Specifying PORT Arrays, Qualified Types and Overloading ,Type Conversion.

Modeling and simulation of digital systems: Adder, Subtractor: Single bit, nibble, byte.

Sequential Code: Latches, Flip Flop, Process statement.

LIST OF EXPERIMENTS

1. Simulation of all basic gates using VHDL.
2. Simulation of single bit half adder and full adder using VHDL.
3. Simulation of single bit half subtractor and full subtractor using VHDL.
4. Simulation of eight bit full adder and full subtractor using structural architecture in VHDL.
5. Simulation of 8x1 multiplexer using 2x1 multiplexer using VHDL.
6. Simulation of D and T flip flop using process statement in VHDL.
7. Using GENERIC data type simulates 8x1 multiplexer using VHDL.
8. Design and simulate a controller for seven segment display using CASE statement.

Text Book:

1. Charles H, Roth Jr., & John, L. K., "*Digital System Design using VHDL*",2nd Ed. Cengage, 2012.
2. Voleni A. Pedroni, "*Circuit Design and Simulation with VHDL*", 2nd Ed. MIT Press, 2010.

Reference Books:

1. Stephen Brown & ZvonkoVranesic, "*Fundamentals of Digital Logic Design with VHDL*" 3rd Ed. McGraw Hill education, 2017.
2. John F Wakerly, "*Digital Design: Principles and Practices*", 4th Ed. Pearson India, 2008.
3. Lecturers of NPTEL.

Course Outcomes:

After the completion of syllabus student will be able to:

1. Understand the need of Hardware Descriptive Languages vs. programming languages.
2. Design and simulate basic gates and combinational circuits using VHDL.
3. Understand the basic data types used in VHDL.
4. Have the knowledge of designing user defined data types.
5. Apply these concepts for adder and subtractor.

Rajani Bisht Jakhtan Vishal Khare

PCC (NET 202)	**Electromagnetic Field Theory**	**3L:1T:0P**	**4 credits**

Review of: Vector Analysis- different coordinates systems, gradient, divergence and curl, Divergence and Stokes theorem, Electrostatic field and magneto static fields.

Time Varying Fields: Continuity equation, Displacement current, Faraday's Law of Electromagnetic Induction, Maxwell's Equations (point form and integral form). Potential Functions, Electromagnetic Boundary Conditions, Time Harmonic Fields

Plane Electromagnetic Waves propagation: Wave Equations & Their Solutions, Plane Waves in Lossless &Lossy Media, Group Velocity, Poynting Vector &Poynting Theorem, Refractions and Reflections at Normal and Oblique Incidence at Plane Conducting and Plane Dielectric Boundary.

Transmission Lines: Transmission line equations, parameters- primary and secondary constants, Analogy of transmission lines, Determination of α, β, γ and vp, characteristics impedance, Input impedance of a lossless line, open and short circuited lines, distortion-less lines, reflection coefficient and standing wave ratio, matched transmission line, Impedance matching, Smith-chart and its applications

Waveguides- Rectangular waveguide, Circular Waveguides. Solution of wave equation in rectangular and cylindrical co-ordinates, Derivation of field equations for TE & TM modes, degenerate and dominant mode, Power Transmission and Power loss, Excitation of waveguides

TEXT BOOKS:

1. William H Hayt , Jr John A Buck,and M. Jaleel Akhtar "*Engineering Electromagnetics*" 9^{th}Ed.McGraw- Hill, 2020.
2. David K Cheng, "*Field and Wave Electromagnetics*", 2^{nd}Ed. Pearson Education India, 2014.
3. Sadiku M H, "*Principles of Electromagnetics*", 6^{th}Ed.Oxford University Press,2015
4. Samuel Y. Liao. "*Microwave Devices and Circuits*" 3^{rd}Ed. Pearson India, 2012

REFERENCE BOOKS:

1. John D. Kraus and Daniel A. Fleisch, "*Electromagnetics with Applications*",5^{th}Ed.McGraw Hill Education, 2017.
2. Karl E. Longman and Sava V. Savov, "*Fundamentals of Electromagnetics with Matlab*", 4^{th}Ed. Prentice Hall of India Learning Pvt. Ltd, 2009.
3. AshutoshPramanik, "*Electromagnetism-Theory and Applications*",2^{nd} Ed. Prentice Hall of India Learning Pvt. Ltd, 2008.
4. Harington, R. F. "*Time Harmonic EM Fields*" 1^{st} Ed. Wiley-IEEE Press, 2001.
5. Schaum's Outlineseries "*Electromagnetics*" Tata McGraw-education 2006.
6. Collin, R. E. "*Antennas and Radio Wave Propagation*" McGraw-Hill Education, 2013

COURSE OUTCOMES:

Upon completion of the course, the students should be able to

1. Analyze different vector coordinates systems, field potentials of electrostatic and magneto static fields.
2. Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.
3. Explain how materials affect electric and magnetic fields and wave propagation.
4. Have knowledge about different parameters and properties of transmission line.
5. Examine the phenomena of wave propagation in different waveguides.

Rajani Bisht Jakhtani Vishal Khare

PCC (NET 204)	**Signals & Systems**	**3L:1T:2P**	**5credits**

Introduction to Signals & Systems: Continuous time and Discrete time signals - Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential; Operations on Signal – Shifting, Scaling, Inversion; Classification of signals - Periodic & Aperiodic, Deterministic & Random, Energy & Power; Continuous-Time and Discrete-Time Systems, Classification of systems – Static & Dynamic, Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable; Continuous-Time and Discrete-Time LTI Systems and their properties, convolution sum and convolution integrals, LTI System described by differential and difference equations.

Fourier Series and Fourier Transform of continuous time signals: The response of LTI Systems to Complex Exponentials, Fourier Series Representation of Continuous-time Periodic Signals, Convergence of Fourier Series, Properties of Continuous time Fourier Series; Continuous time Fourier Transforms, Fourier Transform for periodic signals and their properties, System Characterized by Linear Constant Coefficient Differential equations

Fourier Series and Fourier Transform of discrete time signals: Fourier Series representation of Discrete time periodic Signal and their properties, Representation of Aperiodic Signals: Discrete time Fourier Transform and their properties, Fourier Transform for Periodic Signal, System Characterized by Linear Constant Coefficient Difference equations.

Time and Frequency Characterization of Signals and Systems: Magnitude Phase Representation of the Fourier Transform, Magnitude Phase Representation of the Frequency response of LTI systems, Time domain Properties of Ideal Frequency Selective filter, Time Domain and Frequency Domain aspects of Non ideal filters, First Order and Second Order Continuous Time and Discrete Time Systems.

Sampling: Signal representation by samples, sampling theorem, Reconstruction of a signal from its sample using Interpolation, Aliasing, discrete time processing of continuous time signals, sampling of discrete time signals.

Laplace and Z-Transform: Laplace Transforms, Region of Convergence, Inverse Laplace Transforms, Analysis and Characterization of LTI system, Block diagram representation, unilateral Laplace Transform, z- Transform, Region of convergence, Inverse Z-transform, analysis and characterization of LTI system, Block diagram representation, Unilateral Z-transform.

LIST OF EXPERIMENTS:
Note: At least 08 experiments are to be performed from the following.
All experiments will be carried out on MATLAB software.

1. Introduction of MATLAB, Basic operations on Matrices, and familiarity with some common functions.
2. Plot different continuous and discrete time signals.
3. Perform Shifting, Scaling and Inversion the operation on Rectangular pulse and Sawtooth Waveform.
4. Obtain Real –Imaginary part, Even-Odd part, Energy and Power of a few common signals.
5. Perform convolution of continuous time signals and discrete time signals.
6. Observe Gibbs phenomenon by plotting summation of harmonically related sinusoids to generate square pulse.
7. Find and plot Fourier series coefficients of a few continuous time signals and a few discrete time signals.
8. Obtain Fourier Transform of a few continuous time signals, a few discrete time signals and obtain the original signal using inverse Fourier transform.
9. Verify the Nyquist theorem by carrying out sampling of a continuous time signal and then its interpolation to reconstruct the original signal.
10. Obtain Laplace and z-transform of a continuous and discrete time signal respectively and obtain the original signal using inverse Laplace and inverse z.

Rajani Bisht Jakhtani Vishal Khare

Text Book:

1. Allan V. Oppenheim, S. Wilsky and S. H. Nawab, “*Signals and Systems*”, 2^{nd}Pearson Education 2015

Reference Book:

1. B. P. Lathi, “*Principles of Linear Systems and Signals*”, Second Edition, Oxford 2009.
2. Simon Haykin, Barry Van Veen, “*Signals and Systems*”, Second Edition, Wiley 2021.
3. R. E. Zeimer, W. H. Tranter and R. D. Fannin, “*Signals & Systems - Continuous and Discrete*”, Pearson 2007.
4. John Alan Stuller, “*An Introduction to Signals and Systems*”, Cengage Learning, 2007
5. M.J. Roberts, “*Signals & Systems Analysis using Transform Methods & MATLAB*”, 3^{rd} Ed. McGraw Hill education 2017.
6. Ambardar, Ashok “*Analog and Digital Signal Processing*” 2^{nd} Ed. Cengage Learning, 1999.
7. Mitra, S.K. “*Digital Signal Processing*” 4^{th}McGraw-Hill Education 2013.
8. Chen *“Signals & Systems”*, 3^{rd} Ed.Oxford University Press 2012.
9. Lectures of NPTEL.

Course Outcomes:

Upon completion of the course, students will be able to:

1. Analyze the properties of signals & LTI systems.
2. Represent and analyze continuous time periodic as well as aperiodic signals using Continuous time Fourier series and Fourier transform.
3. Represent and analyze discrete time periodic as well as aperiodic signals using discrete time Fourier series and Fourier transform.
4. Apply the concept of Fourier series and transform in the process of sampling and in the design of filters.
5. Analyze continuous time systems using Laplace-transform and discrete-time systems using z-Transform.

Rajani Bisht Vishal Khare

PCC (NET 206)	**Analog Circuits**	**3L:0T:2P**	**4 credits**

Introduction of this course: Revision of simple diode circuit and its analysis. Revision of BJT - operation and characteristic equations. Revisiting MOSFET - operation and characteristic equations. Analysis of simple non-linear circuits (containing one transistor) and introducing the notion of signal amplification. Input-output transfer characteristic of a non-linear circuit. Small signal models of transistors.

Amplifier models (equivalent circuits): voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Cascading of multiple amplifiers. Common emitter (CE) amplifier – biasing, operation, analysis numerical examples and design guidelines. Common source (CS) amplifier – biasing, operation, analysis, Numerical examples and design guidelines. Frequency response of CE and CS amplifiers. Frequency response of CE and CS amplifiers considering High frequency models of BJT and MOSFET. Limitations of CE/CS amplifiers and hence the need of buffers. Common Collector (CC) and Common Drain (CD) amplifiers– biasing, operation, analysis and design. Common Base (CB) and Common Gate (CG) amplifier – biasing, operation, analysis and design.

Multi transistor Amplifiers (operation and analysis): CE-CC; CS-CD; CC-CC; Darlington pair; Cascode amplifiers (CS-CB and CS-CG); Amplifier with active load. Single-ended signaling vs. differential signaling, Differential amplifier: Basic structure and principle of operation, analysis for differential mode gain, common mode gain, ICMR and output swing, Current mirror- operation and analysis.

Feedback system: Basic feedback theory; Four different feedback configurations and their characteristics. Effects of feedback on frequency response of an amplifier. Application of feedback in practical circuits. Oscillation in feedback system and oscillation criterion, Stability analysis of a feedback system, Two-stage differential amplifier and its stability analysis in feedback configuration.

Oscillator & Waveform-shaping Circuits: Phase-shift and LC based sinusoidal oscillators. Comparator. Square wave generator (Optional) : Power efficiency of an amplifier, Different modes of operation of amplifiers and their power efficiency: Class A, Class B, Class AB and Class C

LIST OF EXPERIMENTS:

Note: At least 08 experiments are to be performed from the following.

1. Designing of Voltage divider and fixed biasing circuit of BJT and implementation of it in PCB.
2. Designing of Voltage divider and fixed biasing of MOSFET and implementation of it in PCB.
3. Study of switching characteristics of BJT and MOSFET
4. Measurement of BJT & MOSFET's h-parameter
5. Designing of controlled gain negative feedback MOSFET / BJT amplifier.
6. Design of an OP-Amp circuit for adding and subtracting operation
7. Design of an OP-Amp circuit for integration and derivative operations
8. Analysis of Hartley & Colpitts Oscillators (LC)
9. Designing of Class A power amplifier to achieve a particular gain
10. Mini-project in design and implementation of an advanced analog circuit (related to this course) using PCB

Rajani Bisht Jakhtani Vishal Khare

Text Books:

1. Ben G. Streetman and Sanjay Kumar Banerjee, *Solid State Electronic Devices*, Pearson, 6/e, 2010.
2. Achuthan, K N Bhat, *Fundamentals of Semiconductor Devices*, 1e, McGraw Hill,2015.

Reference Books:

1. Tyagi M.S., *Introduction to Semiconductor Materials and Devices*, Wiley India, 5/e, 2008
2. Sze S.M., *Physics of Semiconductor Devices*, John Wiley, 3/e, 2005
3. Neamen, *Semiconductor Physics and Devices*, McGraw Hill, 4/e, 2012
4. Pierret, *Semiconductor Devices Fundamentals*, Pearson, 2006
5. Rita John, *Solid State Devices*, McGraw-Hill, 2014
6. Bhattacharya .Sharma, *Solid State Electronic Devices*, Oxford University Press, 2012
7. Dasgupta and Dasgupta , *Semiconductor Devices : Modelling and Technology* PHI Learning Pvt. Ltd.2004.
8. Lectures of NPTEL.

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

1. Analyze the concept of biasing its effect on circuit operation
2. Identify important points on a frequency response curve.
3. Analyze different amplifiers circuits.
4. Analyze different feedback systems.
5. Implement and test the circuits related with signal generator (oscillators) and signal shaping.

Rajani Bisht Jakhtani Vishal Khare

3^{rd} Year

PCC (NET 301)	**Antennas and Wave Propagation**	**3L:1T:0P**	**4 credits**

Electromagnetic Radiation and Antenna Fundamentals: Different types of antenna and Methods of Excitation, Antenna equivalent circuits, radiation mechanism of single wire, two wire and dipole antenna. Antenna characteristics: Radiation pattern, Beam solid angle, Radiation intensity, Directivity, Gain, Input impedance, Polarization, Bandwidth, Effective aperture, Antenna effective height, Antenna temperature.
Wire Antenna -Wire antennas: Hertizian dipole, Short dipole, Radiation resistance and Directivity, Half wave Dipole, Monopole, Small loop antennas.
Aperture Antennas- Aperture Antennas: Slot antenna, Horn Antenna, Pyramidal Horn Antenna, Reflector Antenna- Flat reflector, Corner Reflector, Common curved reflector shapes, parabolic reflector, Lens Antenna, Patch Antennas.
Antennas Arrays: Two Element Array, Horizontal Patterns in Broadcast Arrays, Linear Arrays, Binomial Array, Tschebyscheff Distribution, LF antenna, MF antenna, VHF and UHF antenna. Retarded potential, linear and binomial array,
Wave Propagation: Ground Wave Propagation, Free-space Propagation, Ground Reflection, Surface waves, Diffraction, Wave propagation in complex Environments, Tropospheric Propagation, Space waves, Ionosphere propagation: Structure of ionosphere, Skywaves, Skip distance, Virtual height, Critical frequency, MUF, Electrical properties of ionosphere, Effects of earth's magnetic fields, Faraday rotation.

Text Books:

1. Jordan Edwards C. and Balmain Keith G"*Electromagnetic Waves and Radiating Systems*"2^{nd} Ed. Pearson Education 2015.
2. Samuel Y. Liao. "*Microwave Devices and Circuits*" 3^{rd}Ed. Pearson India, 2012
3. Collin, R. E. "*Antennas and Radio Wave Propagation*" McGraw-Hill Education, 2013
4. C. A. Balanis "*Antenna Theory Analysis and Design*" 3^{rd}Wiley 2009.

Reference Books:

1. Kraus, John D. and Mashefka, Ronald J. / "*Antennas: for All Applications*" McGraw Hill Education 2008.
2. Prasad, K.D. "*Antennas and Wave Propagation*" Satya Prakashan (P) Ltd.2020.
3. William H Hayt , Jr John A Buck,and M. Jaleel Akhtar "*Engineering Electromagnetics*" 9^{th}Ed. McGraw-Hill, 2020.
4. Das, Annapurna & Das, Sisir K. "*Microwave Engineering*" 4^{th} McGraw Hill 2020.
5. Lectures of NPTEL

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
1. Understand the properties and various types of antennas.
2. Analyze the properties of different types of wire antennas and their design.
3. Operate antenna design software tools and come up with the design of the antenna of required specifications.
4. Apply the concepts for understanding different antenna arrays.
5. Have the knowledge of different modes of radio wave propagation and various effecting parameters.

Rajani Bisht Jakhtani Vishal Khare

PCC (NET 303)	Analog Communication	3L:0T:2P	4 credits

Introduction to Communication Systems: Elements and Limitations of Communication Systems, Mathematical Models for Communication Channels, Signals and Signal Space, Frequency Domain Analysis, Fourier Series and Fourier Transform, Energy and Power Spectral Densities, Signal Transmission and Filtering, High Pass and Low Pass RC Circuits, Complex Baseband Representations of Baseband Signals, Modulation and Detection, Different Types of Analog (CW) and Digital Modulation Schemes.

Amplitude (Linear) Modulation: Generation and detection of Conventional AM, DSB-SC, SSB-SC and VSB, Carrier Acquisition, AM Receivers, Multiplexing Systems: TDM, FDM and Audio/Video

Angle (Exponential) Modulation: Representation of FM and PM Signals, Narrow Band & Wide Band FM, Single-tone and Multi-tone FM Waves, Generation and Detection of FM and PM, FDM Transmitter and Receiver, Transmission Bandwidth and Distortion, FM Receivers

Random Processes and Noise: Probability and Random Variables, Random Processes: Description, Basic Concepts and Spectral Analysis, Transmission of Random Processes through LTI Systems, Gaussian and White Processes, External and Internal Source of Noise, Noise Calculations, Noise Figure and Noise Temperature, Noise-Equivalent Bandwidth

Noise Performance of Analog Modulation Systems: Characteristics of Ban-pass Noise, Performance Analysis of AM, DSB-SC and SSBSC Systems with Noise, Performance Analysis of FM and PM Systems with Noise, FM Threshold and its extension, Pre-Emphasis and De Emphasis in FM

List of Experiments:

Note: At least 08 experiments are to be performed from the following.

1. Generation of AM Signal and measurement of Modulation Index.
2. Envelop Detector for AM Signals
3. Generation & Detection of DSB-SC Signal.
4. Generation & Detection of SSB Signal
5. Study of AM Transmitter and Receiver Circuit.
6. Generation of NBFM Signal.
7. Generation of FM Signal.
8. FM Detection using PLL.
9. Generation & Detection of VSB signals.

Text Books:

1. Haykin, S. "*Communication Systems*"5th Ed. Wiley 2009.
2. Lathi, B. P "*Modern Analog & Digital Communication Systems*" 2nd Ed. Oxford University Press 2009.

Reference Books:

1. Taub, Herbert & Schilling, Donald L. Goutam Saha "*Principles of Communication Systems*" 4th Ed. McGraw-Hill Education.
2. Kennedy, G. & Davis, B. "*Electronic Communication Systems*" 6thMcGraw-Hill Education 2017.
3. Carlson, A. Bruce, Crilly, Paul B. & Rutledge, Janet C."*Communication Systems: An Introduction to Signals and Noise in Electrical Communication*" 4th Ed. McGraw-Hill Education2001
4. Singh, R.P. and Sapre, S.D. "*Communication Systems: Analog & Digital*" 3rd Ed. McGraw-Hill Education 2017.
5. Proakis John G. and Salehi Masoud, "*Communication Systems Engineering*",2nd Ed. Prentice Hall of India Pvt. Ltd. 2005.
6. Lectures of NPTEL

Rajani Bisht Jakhtani Vishal Khare

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basics of communication systems, basic resources and their tradeoff, frequency domain analysis and need and types of modulation
2. Do comparative study of various schemes for Amplitude modulation and demodulation for different applications
3. Do comparative study of different types of Angle modulation and various schemes of modulation and demodulation thereof
4. Do the probabilistic analysis of random processes and their frequency domain behavior and to understand the various noise types and noise models
5. Analyze the comparative noise behavior of AM-FM-PM systems and to understand the noise compensation schemes

Rajani Bisht Vishal Khare

PCC (NET 305)	**Linear System Theory**	**3L:1T:0P**	**4 credits**

Module 1: Introduction to Control Problem
Industrial control examples, Mathematical models of physical systems, Control hardware and their models, Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of feedback, Block diagram algebra.

Module 2: Time Response Analysis
Standard test signals. Time response of first and second order systems for standard test inputs, Application of initial and final value theorem, Design specifications for second-order systems based on the time-response, Concept of Stability. Routh-Hurwitz Criteria, Relative stability analysis, Root-Locus technique, Construction of Root-loci,

Module 3: Frequency-response analysis
Relationship between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability using Nyquist criterion – gain and phase margin, Closed-loop frequency response,

Module 4: Introduction to Controller Design
Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems, Root-loci method of feedback controller design, Design specifications in frequency-domain, Frequency-domain methods of design, Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs,

Module 5: State variable Analysis
Concepts of state variables, State space model, Diagonalization of State Matrix, Solution of state equations, Eigen values and Stability Analysis, Concept of controllability and observability, Pole-placement by state feedback, Discrete-time systems, Difference Equations, State-space models of linear discrete-time systems, Stability of linear discrete-time systems, Introduction to Optimal Control and Nonlinear Control, Kalman Base Control

Text/References:

1. M. Gopal, “*Control Systems: Principles and Design*”, McGraw Hill Education, 1997.
2. B. C. Kuo, “*Automatic Control System*”, Prentice Hall, 1995.
3. K. Ogata, “*Modern Control Engineering*”, Prentice Hall, 1991.
4. J. Nagrath and M. Gopal, “*Control Systems Engineering*”, New Age International, 2009 Hands-on/Computer experiments related to the course contents of EEE-303.

Course Outcomes:
At the end of this course students will demonstrate the ability to:
1. Understand the modeling of linear- time-invariant systems using transfer function and state-space representations.
2. Understand the concept of stability and its assessment for linear-time invariant systems.
3. Time domain and frequency domain analysis of the systems
4. Design and analysis of feedback controllers
5. Analyze the stability of Discrete-time systems

Rajani Bisht Jakhtan Vishal Khare

PCC (NET 307)	**Microprocessors and Microcontroller**	**3L:0T:2P**	**4 credits**

Introduction to Microprocessors: Introduction to 8085: Architecture, Register structure, ALU, Bus Organization, Timing and Control.

Architecture of 16-bit Microprocessor (8086): Internal Organization and pin description of 8086, Bus Interface Unit (Address and Data bus Demultiplexing), Execution unit, Register Organization, Memory Organization, Bus Cycle, Clock generation. Machine and Instruction cycle, Addressing Modes, Interrupt Structures, 8086 Instructions set; Introduction and brief discussion of the 32 Bit and 64-bit Microprocessor architecture.

Basic I/O Interfacing: Programmed I/O, Interrupt Driven I/O, DMA; Parallel I/O: 8255- PPI, Minimum Mode CPU Module, Maximum Mode operation,Serial I/O: 8251, Programmable Interrupt Controller: 8259; 8257 - DMA Controller, 8253/8254 - Programmable Timer/Counter; ADC and DAC interfacing, Memory Interfacing.

Introduction to Microcontroller: 8051 Introduction, architecture, instruction set, timers/counters, interrupts and serial interface, Memory organization. Introduction to RISC processor.RISC Architecture and its operation principle.

ARM (Advanced RISC Microprocessor): Architecture of ARM Cortex M3 and instruction sets, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, Memory mapping, Bus interfaces.

LIST OF EXPERIMENTS:
Note: At least 08 experiments are to be performed from the following.

8085/8086/ARM Based Experiments:
1.Signed and unsigned binary addition.
2.Signed Multiplication.
3.Signed and unsigned binary division.
4.BCD Addition and subtraction
5.Look up table method for finding the ASCII of an alpha-numeric code.
6.Toggle the LED's with some time delay using ARM
7. Program for interfacing the LCD with ARM
8.Interfacing with 8255 in I/O mode/BSR mode.
9.Interfacing with seven segment display.
10.Interfacing with 8253.
11.Verification of Interrupts.
12.Interfacing with ADC/DAC.
13.Mini Project on some interfacing applications (preferably ARM based)

Text Books:

1. Brey, Barry B., "*INTEL microprocessors*" Prentice Hall (India), 4th Ed., 2008.
2. Gaonkar, Ramesh S., "*Microprocessor Architecture*, *Programming, and Applications with the 8085*", Pen ram International Publishing / 5th Ed., 2000.
3. Liu and Gibson G.A., "*Microcomputer Systems: The 8086/8088 Family*", Prentice Hall (India) 2nd Ed, 1985.
4. Hall D.V., "*Microprocessors Interfacing*", Tata McGraw Hill, 2nd Ed., 2006.

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Reference Books:

1. Singh, B.P., "*Advanced Microprocessors and Microcontrollers*", 3edi, New Age International, 2008.
2. Ray, A.K. &Burchandi, K.M., "*Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing*", 3edi., Tata McGraw Hill, 2017.
3. Ayala, Kenneth J., "*The 8086 Microprocessor Programming & Interfacing The PC*", Pen ram International Publishing (India) Limited, 2007.
4. Lectures of NPTEL

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand 16 bit and32 bit microprocessor; apply those concepts on advance processor.
2. Formulate a real world problem in assembly language programming.
3. Do interfacing design of peripherals like, I/O, A/D, D/A, timer etc.
4. Understand the concept of microcontroller and RISC processor.
5. Have the basic knowledge of ARM processor and its operation.

Rajani Bisht Jakhtani Vishal Khare

PCC (NET 309)	**VLSI Technology**	**3L:1T:0P**	**4 credits**

Crystal Growth & Wafer Characterization: Electronic Grade Silicon, CZ Crystal, Growing, Silicon Shaping, Processing Consideration. Material Characterization

Epitaxy: Vapor Phase Epitaxy, Molecular Beam Epitaxy

Oxidation: Growth Mechanisms, Thin Oxides, Oxide Properties, Oxidation Induced Defects, oxide thickness Characterization

Lithography: Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography

Etching: Wet Chemical Etching: Silicon, SiO_2, Silicon Nitride, Polysilicon, Aluminium, GaAs;Reactive Plasma Etching (Dry)**:** Feature Size Control in Isotropic and Anisotropic, Etch Mechanisms, Reactive Plasma Etching Techniques and Equipment

Diffusion: Models of Diffusion in Solids, Fick's One Dimensional Diffusion Equations, Atomic Diffusion Mechanisms

Ion Implantation: Range Theory, Implantation Equipment, Implant damage and Annealing, Implantation related processes

Dielectric and Polysilicon Film Deposition: Deposition Processes (CVD & MBE), Poly Silicon, Silicon Dioxide, Silicon Nitride, SLow-dielectric-Constant Material, High-dielectric-Constant Material

Metallization: Metallization Applications, Metallization Choice, Physical Vapour Deposition, Chemical Vapour Deposition, Aluminium Metallization, Copper Metallization. Patterning,

Process Integration: Passive Component, Bipolar IC Technology, MOSFET Technology, MESFET Technology and MEMS Technology, Packaging

Text Books:

1. Sze, S.M./ "*VLSI Technology*" / 2nf Ed. McGraw-Hill education 2017.
2. James D. Plummer, M
3. Michael Deal, and Peter B. Griffin, / "*Silicon VLSI Technology: Fundamentals, Practice and Modelling*"/ 1st Pearson 2000.
4. Streetman, B.G. & Banerjee, Sanjay "*Solid State Electronic Devices*" Prentice Hall (India) 2014.

Reference Books:

1. Campbell, Stephen A. / "*The Science & Engineering of Microelectronic Fabrication*" 2ndOxford University Press 2012.
2. Gandhi, S. "*VLSI Fabrication Principle: Silicon and Gallium Arsenide and Fabrication*" 2ndWiley 2008
3. Lecturers of NPTEL.

Course Outcomes:

At the end of course student will be able to

1. Understand the basic process of crystal growth and different steps for fabrication of ICs
2. Understand the concept of crystal growth, epitaxy and on film deposition
3. Understand basic steps for formation of ICs like lithography, Etching, Ion implantation, Metallization.
4. Understand the process integration concept of IC Technology
5. Apply these concepts to finalized the fabrication process of different types of MOSFETs

Rajani Bisht Jakhtani Vishal Khare

PCC (NET 302)	**Analog Integrated Circuit**	**3L:1T:0P**	**4 credits**

Single Stage Integrated Circuit Amplifiers: Comparison of the MOSFET, BJT & Bi-CMOS Circuits, IC Biasing & Modified Current Sources, Advance current mirrors, Amplifiers with Active Load, Cascode Amplifier, folded Cascode.

Differential Amplifiers: MOS Differential Pair, Non Ideal Characteristics of the Differential Amplifier, Differential Amplifier with Active Load, Freq. Response of Differential Amplifier, Two Stage CMOS Op-Amp, Introduction to OTA

Data Converters: DAC/ADC

Filters: Active Filters: Transmission, Types & Specifications, Transfer Function, Butterworth & Chebyshev Filters, First Order & Second Order Filter Functions, Biquadratic and state-variable filters, Noise in Devices, Switched capacitor filters

Signal Generators & Wave Shaping Circuits: Bi-Stable Circuits**,** Comparator, Schmitt Trigger, Generation of Square & Triangular Waveforms, sample and hold circuit, Integrator, differentiator IC Timer 555 and its Applications, PLL and its Applications, Precision Rectifier Circuits, Voltage Regulators ICs, SMPS.

LIST OF EXPERIMENTS:

Note: At least 08 experiments are to be performed from the following.

1. Measurement of Op-amp Parameters.(Open Loop Gain, input offset Voltage, CMRR, Slewrate).
2. Determination of Frequency response of Op-Amp.
3. Precision Rectifier.
4. Instrumentation Amplifier.
5. Open Loop operation of Op-amp-Comparators-Schmitt Trigger.
6. PAM, PWM, PPM generation and detection
7. IC Voltage Regulator.
8. Voltage Controlled Oscillator.
9. Phase Locked Loop.
10. Frequency Multiplier.
11. A/D Converters & D/A Converters.
12. Second Order Active Filter-High Pass & Low Pass Realization.

Text Books:

1. Sedra, Adel S., Smith, KennethC. / "*Microelectronic Circuits*" / Oxford University Press, 2009

2. Millman,J.& Grabel,A. / "*Microelectronics*"/McGraw-Hill, 2009.

Reference Books:

1. Gray,P.R., Hurst,P.J., Lewis,S.H .& Meyer,R.G. / "Analysis and Design of Analog Integrated Circuits"/ John Wiley & Sons/.
2. Gayakwad, R.A./ "Op-Amps and Linear Integrated Circuits"/ Prentice-Hall (India).
3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", MGH.
4. J.Michael Jacob, "Applications and Design with Analog Integrated Circuits", PHI
5. Tony Chan Carusone David A. Johns Kenneth W. Martin/ "Analog Integrated Circuit Design" / John Wiley & Sons,/2nd ed

Rajani Bisht Jakhtan Vishal Khare

Course Outcomes:

At the end of course student will be able to

1. Understand the basic process of crystal growth and different steps for fabrication of ICs
2. Understand the concept of crystal growth, epitaxy and on film deposition
3. Understand basic steps for formation of ICs like lithography, Etching, Ion implantation, Metallization.
4. Understand the process integration concept of IC Technology
5. Apply these concepts to finalized the fabrication process of different types of MOSFETs

Rajni Bisht

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PCC (NET 304)	**Digital Communications**	**3L:1T:0P**	**4 credits**

Elements of Digital Communication Systems and Information Theory: Analog Vs Digital Communication Systems, Model of a Digital Communication System, Modeling of Information Sources, Source Coding Theorem, Huffman and Lempel-Ziv Source Coding Algorithms, Rate Distortion Theory

Waveform Coding and Transmission through Band-limited Channel: Sampling of Band-pass Signals, PAM and TDM, PWM and PPM, Quantization and Quantization Error, Elements of Pulse Code Modulation (PCM) System, Companding, DPCM, DM, and ADM, Comparative Assessment of different Line Codes and their Power Spectra, Signal Design for Band-limited Channels: ISI, Nyquist Criterion For Zero ISI & Raised Cosine Spectrum, Channel Estimation: Concept and Criterion, Equalization

Digital Modulation: Geometric Representation of Waveforms, 1-d, 2-d and Multi-d Signal Waveforms, Correlation Type and Matched Filter Type Demodulators, Optimum Detector, Types of Digital Modulation Techniques and their Waveforms, Binary Modulation Techniques: ASK, PSK, DPSK and FSK; M-ary Modulation Techniques: MPAM, QPSK, OQPSK, π/4-DQPSK, QAM; MSK, Error Probability for Signal Detection in AWGN, Comparison of Various Digital Modulation Techniques

Spread Spectrum and Multiple Access Techniques: Introduction to Spread Spectrum Modulation, TDMA, FDMA and CDMA, Fundamentals of OFDM

Error Control Coding: Error Free Communication over a Noise Channel, Linear Block Codes, Cyclic Codes, and Convolution Codes

Text Books:

1. J. G. Proakis & M. Salehi, "*Communication Systems Engineering*", 2nd Edition, Pearson Education, 2002.
2. Haykin, Simon, "*Communication Systems*", John Wiley, 2013.

References Books:

1. Simon Haykin, "*Digital Communication*", John Wiley, 2013.
2. Taub& Schilling, "*Principles of Communication Systems*" 3Edition, Tata McGraw-Hill, 2011
3. Lathi, B.P, "*Modern Digital & Analog Communication Systems*", 3rd ed, Oxford University Press, 1998
4. Proakis J.J, "*Digital Communications*"McGraw Hill, 2000.
5. Lectures of NPTEL

Course Outcomes:
At the end of this course students will demonstrate the ability to

1. Analyze and compare different digital modulation schemes for their efficiency and bandwidth
2. Investigate pulsed modulation system and analyze their system performance.
3. Understand different multiple access schemes.
4. Analyze different digital modulation schemes and can compute the bit error performance.
5. To learn about different digital multiplexing and error control coding schemes

Rajani Bisht Jakhtani Vishal Khare

PCC (NET 306)	**VLSI Design**	**3L:1T:2P**	**5 credits**

Introduction: Digital Integrated Circuit Design, Quality Metrics of a Digital Design, Review of the Manufacturing Process.

The Devices: Spice Diode Model, The MOSFET Transistors: The MOS Transistor Under Static Condition, Secondary Effects, Spice Models For the MOS Transistors, Scaling, Circuit Simulation

The CMOS Inverter: The Static CMOS Inverter, Performance of CMOS Inverter, Power, Energy and Energy Delay

Designing Combinational Logic Gates in CMOS: Static CMOS Design, Dynamic CMOS Design, Simulation and Layout Techniques for Logic Gates

Designing Sequential Logic Circuits: Static Latches and Register, Dynamic Latches and Register

Designing Arithmetic Building Blocks: Adders, Designing Memory and Implementation Strategies for Digital ICs

Designing Complex Digital Integrated Circuits: The Standard-cell Design Approach, Cell Based Design Methodology, Array-based Design

List of Experiments:

1. Design, Simulation and Analysis of following circuits using Circuit simulator:
    a. NMOS and CMOS inverter
    b. Two input NAND Gate
    c. Two input NOR Gate
2. Simulation of Full Adder using HDL
3. Simulation of BCD to Seven Segment using HDL
4. Simulation of MUX using VHDL
5. Simulation of RS Flip Flop.
6. Mini project.

Text Books:

1. Rebaey, John M. & Chandrakasan, Anantha&Nikolic, Borivoje / "*Digital Integrated Circuits: A Design Prospective*" / Pearson Education / 2nd Ed.

References Books:

1. Kang, Sun-mo&Leblebici, Yusuf / "*CMOS Digital integrated Circuits, Analysis & Design*"/Tata McGraw-Hill / 3rd Ed.
2. Pucknell, Douglas A. &Eshraghian, Kamran / "*Basic VLSI Design*"/ Prentice – Hall (India).
3. Razavi, Behzad / "*Design of Analog CMOS integrated circuits*" / Tata McGraw-Hill.
4. Wayne Wolf, "*Modern VLSI Design- Systems on Silicon*" / Addison-Wesley / 2nd Ed.
5. Geiger, R.L., Allen, P.E. &Strader, N.R. / "*VLSI: Design Techniques for Analog & Digital Circuits*" / McGraw-Hill.
6. Weste, N.H.E. &Eshraghian, K. / "*Principles of CMOS VLSI Design*" / Pearson Education Asia

Rajani Bisht Jakhtani Vishal Khare

Course Outcomes

1. At the end of this course students will demonstrate the ability to
2. Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.
3. Design Complementary MOSFET based logic circuit
4. Synthesis of digital VLSI systems from register-transfer or higher level descriptions in hardware design languages. Realize logic circuits with different design styles.
5. Get the basic detail for designing of Sequential circuits.
6. Learn about the designing of different arithmetic building blocks.

Rajani Bisht Vishal Khare

PCC (NET 308)	**Digital Signal Processing**	**3L:0T:2P**	**4 credits**

Structures for Discrete-Time Systems: Block Diagram Representation, Signal Flow Graph Representation, Basic Structures for IIR Systems: Direct Form, Cascade Form, Parallel Form, and Feedback in IIR Systems. Transposed Forms, Basic Network Structures for FIR Systems, Direct Form, Cascade Form, Structures for Linear-Phase FIR Systems.

Coefficient Quantization of Discrete-Time Systems: Overview of finite precision Numerical Effects, Effects of Coefficient quantization, Effects of Round-off Noise in Digital Filters, Zero-input Limit cycles in Fixed-point Realizations of IIR Digital filters.

Digital Filter Design Techniques: Design of D-T IIR Filters from continuous-time filters, Design of FIR filters by windowing, Kaiser Window method, Optimum Approximations of FIR Filters, FIR Equiripple approximation.

Discrete and Fast Fourier Transforms: Discrete Fourier transform, Properties, Linear convolution using DFT, DCT, Efficient computation of the DFT, Goertzel algorithm, Decimation in time and decimation in frequency FFT algorithm, Practical considerations, Implementation of the DFT using Convolution, Effects of Finite Register Length.

List of Experiments:

Note: At least 08 experiments are to be performed from the following.

1. Sampling & Waveform Generation.
2. DFT Computation.
3. Analysis of different windows
4. Design of FIR Filter
5. Design of IIR Filter
6. Implementation of FFT algorithm
7. Quantization and analysis of FIR filter
8. Quantization and analysis of IIR filter
9. Floating point Implementation of FIR and IIR filtering using digital signal processors.
10. Fixed point Implementation of FIR and IIR filtering using digital signal processors.

Text Books:

1. Oppenheim A.V., Schafer, Ronald W. & Buck, John R. / "*Discrete Time Signal Processing*" / Pearson Education / 2nd Ed. / Prentice-Hall (India)
2. Sen M. Kuo & Woon-Seng S. Gan, "Digital *Signal Processors-architectures, implementation and applications*" / Pearson Education /I Ed.

Reference Books:

1. Proakis, J.G. & Manolakis, D.G. / "*Digital Signal Processing: Principles Algorithms and Applications*" / Prentice Hall (India) / Pearson Education
2. Oppenheim A.V. & Schafer, Ronald W. / "*Digital Signal Processing*" / Pearson Education
3. Rabiner, L.R. and Gold B./ "*Theory and applications of DSP*" / Prentice Hall (India)
4. Oppenheim, Alan V. & Willsky, Alan S. / "*Signals and Systems*" / Prentice Hall (India)
5. Johnson, J.R. / "*Introduction to Digital Signal Processing*" / Prentice Hall (India)
6. DeFatta, D.J., Lucas, J.G. & Hodgkiss, W.S / "*Digital Signal Processing*"/ John Wiley & Sons.

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Jakhtan
Vishal Khare

Course Outcomes:

At the end of course student will be able to

1. Learn the basic forms of FIR and IIR filters, and how to design filters with desired frequency responses using MATLAB.
2. Analyze the effect of coefficient quantization in digital filters for processing of discrete time signals.
3. Master the representation of discrete-time signals in the frequency domain using discrete Fourier transform (DFT).
4. Understand the implementation of the DFT in terms of the FFT, as well as its application i.e. computation of convolution sums.
5. Employ signal processing strategies at multidisciplinary team activities.

PEC-I

PEC-I (NET322)	Digital System Design Using VHDL	3L:0T:0P	3 credits

Review of Logic Design Fundamentals: Combinational logic, Boolean Algebra and Algebraic Simplification, Karnaugh maps, Designing with NAND and NOR gates, Hazards in combinational Networks, Flip-flop and Latches, Mealy Sequential Network Design, Design of Moore Sequential Network, Equivalent states and reduction of state Tables, Synchronous Design, Tristate Logic andBuses

Introduction to VHDL: VHDL Description of Combinational Networks, Modeling Flip-flopsusing VHDL Processes, VHDL Models for a Multiplexer, Modeling a sequential Machine, Variables, signals, and constants, Arrays, VHDL operators, VHDL Functions, VHDL Procedures, Packages and Libraries.

Styles of Descriptions: VHDL Data types, VHDL Styles of Description. Data flow Description: Highlights of Data flow Description, Structure of Data flow Description, Data type-vectors, Common VHDL programming Error

Designing with programmable Logic Devices: Read only memories, Programmable Logic Arrays, Programmable Array Logic, Other sequential programmable Logic Devices (PLDs), Generics, Generate statements. Design of Networks for Arithmetic Operations: Design of serial Adder with Accumulator, Design of Binary Multiplier, Multiplication of signed Binary Numbers, Design of Binary Divider

Synthesis: Highlights of synthesis, synthesis information from entity and module, Mapping process in the hardware domain- Mapping of signal assignment, variable L1, L2, L3 assignment, if statements, else-if statements, loop statement.Hardware Testing and Design for Testability: Testing Combinational Logic, Testing Sequential Logic

Text Book:

1. Charles H Roth Jr, "*Digital System Design using VHDL"*, Thomson Learning, 2006.

Reference Books:

1. Stephen Brown &ZvonkoVranesic, "*Fundamentals of Digital Logic Design with VHDL",* TMH, 2006.
2. John F Wakerly, "*Digital Design*", PHI, 1994.
3. Lecturers of NPTEL

Course Outcomes:

At the end of course student will be able to

1. Understand the basic syntax of VHDL and IEEE libraries for modeling of combinational and sequential circuits.
2. Design different networks for arithmetic operation and on floating point arithmetic.
3. Design SM chart for real world problems.
4. Understand the different families of Xilinx FPGA and bus model.
5. Apply these concepts to understand UART and microcontroller.

Rajani Bisht Jakhtani Vishal Khare

PEC-I (NET324)	Filter Design and Analysis	3L:0T:0P	3 credits

Filter Concepts: Frequency Response and Filter Characteristics, FIR Filters and Linear Phase, IIR Filters, Allpass Filters, Transfer Function of Allpass Filters, Minimum-Phase Filters using Allpass Filters, Ideal Sampling, Sampling of Sinusoids and Periodic Signals, Sampling of Bandpass Signals, Natural Sampling or Pulse-Amplitude Modulation, Zero-Order-Hold Sampling, Sampling, Interpolation, and Signal Recovery, Sampling Rate Conversion, Quantization

Digital Processing of Analog Signals: Practical ADC Considerations, Anti-Aliasing Filter Considerations, Dynamic-Range Processors, Audio Equalizers, Digital Audio Effects, Multirate Signal Processing

Design of Recursive Digital Filters: Filter Specifications, Techniques of Digital Filter Design, Recursive Digital Filters Filter Design, Response Matching, The Matched z-Transform for Factored Forms, Mappings from Discrete Algorithms, The Bilinear Transformation, Spectral Transformations for IIR Filters

Design of Non-Recursive Digital Filters: Ideal Filters, Symmetric Sequences and Linear Phase, Window-Based Design, Half-Band FIR Filters, Filter Design by Frequency Sampling, Design of Optimal Liner-Phase FIR Filters, Application: Multistage Interpolation and Decimation, Maximally Flat FIR Filters, FIR Differentiators and Hilbert Transformers, Least Squares and Adaptive Signal Processing

Effects of Finite Word Length in Digital Filters: Introduction, Rounding and Truncation Errors, Quantisation Effects in Analog-to-Digital Conversion of Signals, Output Noise Power from a Digital System, Coefficient Quantisation Effects in Direct form Realisation of IIR Filters, Coefficient Quantisation in Direct form Realisation of FIR Filters, Limit Cycle Oscillations, Product Quantisation, Scaling, Errors in the Computation of DFT Quantisation.

Adaptive Filters: Introduction, Filtering Structure, The Steepest Descent Algorithm (SDA),Least Mean Square (LMS) Algorithm, Recursive Least Square (RLS) Algorithm, The Minimum Mean Square Error Criterion, The Forward-Backward Lattice Method, Gradient Adaptive Lattice Method, Applications of Adaptive Filtering.

Text Book:

1. Ashok Ambardar, "*Digital Signal Processing: A modern Introduction*", Cengage learning, 2006.
2. S. Salivahanan, "*Digital Signal Processing*", 4th Edition McGraw Hill Education, 2001.

Course Outcomes:

On completion of the course, student will be able to:

1. Learn the concepts of filter design.
2. Apply the knowledge of filter to Digital Processing of Analog Signals.
3. Apply the concept of Digital Processing to Design of Recursive and non recursive Digital Filters.
4. Analyze the Effects of Finite Word Length in Digital Filters.
5. Learn and design the Adaptive Filters.

Rajani Bisht Jakhtani Vishal Khare

PEC-I (NET326)	**Microwave and Radar Engineering**	**3L:0T:0P**	**3 credits**

Microwave Passive Components- Scattering matrix- Concept of N port Scattering matrix representation, Properties of S matrix- S matrix formulation of two-port junction. Microwave junctions-Tee junctions E-Plane Tee, H- Plane Tee and Magic Tee, Corners, bends and twists, Directional couplers- two hole directional couplers- Ferrites –important microwave properties and applications, Isolator, Circulator, Attenuator, Phase shifter.

Microwave Semiconductor Devices- Principles of operation – characteristics and application of tunnel diodes, PIN diode and LSA. Transferred Electron Devices – Gunn diode-Avalanche Transit time devices IMPATT and TRAPAT, Parametric devices - Principles of operation - applications of parametric amplifier

Microwave tubes: Limitations of conventional tubes in the microwave frequency range, O-type and M-type tubes. Klystron amplifier, Reflex Klystron oscillator, Magnetron, Traveling wave tube

Introduction of Radar: Principle of detection and ranging, Radar frequencies and bands. Applications, Radar block diagram and operation. Radar Range Equation: Range prediction, Minimum detectable signal, Receiver noise SNR, Integration of radar pulse. Radar cross section of targets, Transmitter Power, PRF and system losses & Propagation effects

MTI & Doppler radar: Doppler effect, CW radar, FM CW, Delay line cancellers, Multiple or staggered, PRF, Non coherent MTI, Pulse Doppler Radar, Radar Imaging, Earth penetrating radar, Radar clutter, different Radar antenna.

Text Book:

1. Skolnik M. I., "*Introduction to Radar Systems*", McGraw-Hill, 1980.
2. Nagraja, N.S., "*Elements of Electronic Navigation*", Tata McGraw Hill, 2002.
3. Liao, S.Y., "*Microwave Devices & Circuits*", Prentice Hall (India), 3rd Ed., 2008.

Reference Book:

1. Nathanson, Fred E., "*Radar an Overview Design Principles*", Prentice–Hall (India)
2. Toomay, J. C., "*Principles of Radar*", 2nd edition, Prentice–Hall (India), 2005.
3. Das, Annapurna & Das, Sisir K., "*Microwave Engineering*", Tata McGraw Hill, 2000.
4. Roy, Sitesh Kumar &Mitra, Monojit, "*Microwave Semiconductor Devices*", Prentice Hall, 2003.
5. Lecturers of NPTEL.

Course Outcomes:

At the end of course student will be able to

1. Understand the design of simple microwave passive circuits and devices
2. To study different microwave semiconductor devices.
3. Understand various microwave tubes.
4. Understand the basic concept and working of Radar
5. Apply these concepts on MTI and Doppler Radar

Rajani Bisht Jakhtani Vishal Khare

PEC-I (NET 328)	Data Communication & Network	3L:0T:0P	3 credits

Introduction: Data Communications, Networks, The Internet, Protocols and Standards, Network Models, Layered Architecture, The OSI Model, Layers in the OSI Model, TCP/IP Protocol Suite, Addressing, Review of Physical Layer and Transmission Media.Hardware communication protocols for e.gRS422, RS232, CAN, I2C, SERDES, LVDS, Ethernet, MIL 1553B

Switching: circuit switching, packet switching, message switching, Circuit-Switched Networks, Datagram Networks, Virtual-Circuit Networks, Structure of a Switch, Using Telephone and Cable Networks for Data Transmission, Telephone Networks, Dial-up Modems, Digital Subscriber Line, Cable TV Networks, Cable TV for Data Transfer.

Data Link Control, Framing, Flow and Error Control, Protocols, Noiseless Channels, HDLC, Point-to-Point Protocol, Multiple Access, Random Access, Controlled Access, Channelization, MAC Level IEEE Standards, Standard Ethernet, Changes in the Standard, Fast Ethernet, Gigabit Ethernet, IEEE 802.11, Bluetooth.

Connecting LANs, Backbone Networks and Virtual LANs, Connecting Devices, Backbone Networks, Virtual LANs, Sonet/SDH, Architecture, Sonet Layers, Sonet Frames, STS Multiplexing, Sonet Networks, Virtual Tributaries, Virtual-Circuit Networks: Frame Relay and ATM, Frame Relay, ATM, ATM LANs.

Networks Layer: Logical Addressing, IPv4 Addresses, IPv6 Addresses, Network Layer: Internet Protocol, Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6, Network Layer: Address Mapping, Error Reporting, Forwarding and Routing, Unicast Routing Protocols.

TextBooks:

1. BehrouzaA.Forouzan,“*DataCommunicationsandNetworking*”,FourthEdition, TMH, 2007.
2. A.S.Tanenbaum,“*ComputerNetworks*”,4thedition,Pearsoneducation, 1996.

ReferenceBooks:

1. W.Tomasi,“*IntroductiontoDatacommunicationsandNetworking*”,Pearsoneducation, 2004.
2. G.S.Huraand M.Singhal,“*DataandComputerCommunications*,CRCPress”,TaylorandFrancisGroup, 2001.
3. S.Keshav, “*AnEngineeringApproachtoComputerNetworks*” 2nd Edition,PearsonEducation, 2001.
4. L.L.PetersonandB.S.Davie,“*ComputerNetworks*”,4th editionELSEVIER, 2019.
5. JamesF.Kurose,K.W.Rose,“*ComputerNetworking:ATop-DownApproachFeaturingtheInternet*”,3rdEdition, PearsonEducation, 2017.
6. WilliamStallings,“*DataandComputerCommunications*”,PrenticeHall, 2017.
7. F.Halsall, “*DataCommunications,ComputerNetworks,andOpenSystems*”,Addison-Wesley, 1995.

Course Outcomes:

At the end of course student will be able to

1. To understand the basics of OSI and TCP/IP models and review of Physical Layer concept.
2. To understand basic concepts of Switching and cable networks.
3. Apply the concept of flow control in Data Link layer.
4. To study different LAN networks.
5. To understand basic concepts of Network Layer.

Rajani Bisht Jakhtani Vishal Khare

PEC-I (NET 330)	**Advanced Semiconductor Devices**	**3L:0T:0P**	**3 credits**

Energy Bands & Charge Carriers in Semiconductors: Bonding Forces & Energy Bands in Solid, Charge Carriers in Semiconductors, Carrier Concentrations, Drift of Carriers in Electric & Magnetic, Fields, Invariance of the Fermi Level at Equilibrium,

Excess Carriers in Semiconductors: Optical Absorption, Luminescence, Carrier, Lifetime& Photo Conductivity, Diffusion of Carriers

Junctions: Fabrication of P-N Junctions, Equilibrium Condition, Forward & Reverse Bias Junctions, Reverse Bias Breakdown, Transient & AC Conditions, Deviations from the Simple Theory, Metal Semiconductor Junctions, Hetero-Junction

Field Effect Transistors: Transistor Operation, the Junction FET, the Metal Semiconductor FET, the Metal insulator, Semiconductor FET, MOSFET, BJT

Fundamentals of BJT Operation: Amplification with BJT, BJT Fabrication, Minority Carrier Distributions & Terminal Currents, Generalized Biasing, Switching, Other Important Effects, Freq. Limitation of Transistors, Hetero-Junction BJT

Optoelectronic Devices: Photodiodes, Light Emitting Diodes, Lasers, Semiconductor Lasers

Text Book:

1. Streetman, B.G. & Banerjee, Sanjay, "*Solid State Electronic Devices*", Prentice Hall (India), 2005.

Reference Books:

1. Karl, Hess, "*Advance Theory of Semiconductor Devices*", Prentice Hall (India), 1987.
2. Sze, S.M., "*Physics of Semiconductor Devices*", 2nd edWiley Eastern Limited, 1981.
3. Watson, H.A., "*Microwave Semiconductor Devices and Their Circuit Applications*" Tata McGraw-Hill, 2007.
4. Bell, David A., "*Electronic Devices & Circuits*",4th Edition, Prentice Hall (India)1999.
5. Nair, B. Somanathan, "*Electronic Devices & Applications*"Prentice Hall (India), 2009.
6. Roy, Sitesh Kumar &Mitra, Monojit, "*Microwave Semiconductor Devices*"Prentice Hall (India)
7. Salivahanan, S. & Kumar, Suresh N. &Vallavraj, "*Electronic Devices & Circuits*"Tata McGraw-Hill, 2007.
8. Neamen, Donald A., "*Semiconductor Physics & Devices*", Tata McGraw-Hill, 2021.
9. Das Gupta, N., "*Semiconductor Devices Modeling & Technology*" Prentice Hall (india), 1989.
10. Muller, Richard &Kamins, Theodone L., "*Device Electronics for IC*" John Wiley, 1983.
11. Lecturers of NPTEL.

Course Outcomes:

At the end of course student will be able to

1. Understand the basic concept for formation of energy band, charge carriers and excess charge carriers.
2. Apply these concepts to understand the operation of different electronic devices like diode, BJT, JFET and MOSFET.
3. Analyze the working of these devices and solve mathematical problems of Diode, BJT, MOSFET and Diode.
4. To design a circuit using transistor at a desired operating point.
5. Apply these concepts on to understand the operation of heterojunction devices and have the basic knowledge of optically active devices.

Rajani Bisht Jakhtani Vishal Khare

PEC-II

PEC-II (NET421)	Semiconductor Device Modeling	3L:1T:0P	4 credits

Introduction, Semi-classical Bulk Transport – Qualitative Model, Semi-classical Bulk Transport – EM field and TransportEquations,

Drift-Diffusion Transport Model – Equations, BoundaryConditions, Mobility and Generation / Recombination, Characteristic times and lengths, Energy band diagrams.

SQEBASTIP: The Nine Steps of Deriving a DeviceModel, Types of Device Models.MOSFET Model: Structure and Characteristics,Qualitative Model,

MOSFET Model: Equations, Boundary Conditions andApproximations,

MOSFET Model: Surface Potential based andThreshold based solutions, MOSFET Model: Testing, Improvement and ParameterExtraction.

Text/References Books:

1. M. Lundstrom, "*Fundamentals of Carrier Transport*", Cambridge University Press,2000.
2. C.Snowden,"*Introduction to Semiconductor Device Modeling*", World Scientific, 1986.
3. Y. Tsividis and C. McAndrew,"*MOSFET modeling for Circuit Simulation*", OxfordUniversity Press, 2011.
4. BSIM Manuals available on BSIM homepage on the internet.
5. NPTEL ONLINE LECTURES.

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

1. Explain the equations, approximations and techniques available for deriving a model with specified properties, for a general device characteristic with known qualitative theory
2. Apply suitable approximations and techniques to derive the model referred to above starting from drift-diffusion transport equations (assuming these equations hold)
3. Offer clues to qualitative understanding of the physics of a new device and conversion of this understanding into equations
4. Simulate characteristics of a simple device using MATLAB, SPICE
5. Explain how the equations get lengthy and parameters increase in number while developing a compact model
6. List mathematical functions representing various non-linear shapes

Rajani Bisht Jakhtani Vishal Khare

PEC-II (NET 423)	**Image Processing**	**3L:1T:0P**	**4 credits**

Digitized Image & Its Properties: Basic Concepts, Image Digitization, Digital Image Properties

Data Structure for Image Analysis: Label of Image Data Representation, Traditional Image Data Structures, Hierarchical Data Structures

Image Processing: Pixel Brightness, Transformation, Geometric Transformation, Local Preprocessing, Image Restoration

Segmentation: Thresholding, Edge Based Segmentation, Region Based Segmentation, Matching

Shape Representation: Region Identification, Contour Base Representation, Region Based Shape Representation, Shape Classes

Image Transforms: Two Dimensional Orthogonal and Unitary Transforms, Properties of Unitary Transforms, Two Dimensional DFT, Cosine Transforms, Sine Transforms, Hudmard Transforms, KK Transforms, SVD Transforms, ; Wavelets and Multiresolution Processing, Wavelet Transformation in one dimension, Wavelet Transformation in two dimensions;

Image Enhancement: Point Operation, Histogram Modeling, Transform Operation

Image Data Compression: Image Data Properties, Discrete Image Transforms in Image Data Compression, Predictive Compression Methods, Vector Quantization, Hierarchical and Progressive Compression Methods, Comparison of Compression Methods, Coding, JPEG and MPEG Image Compression.

3D Vision, Geometry and Radiometry: 3-D Vision Tasks, Geometry for 3-D Vision, Radiometry and 3-D Vision, 3-D Model Based Vision, 2-D Based Representation of a 3-D Scheme.

Text /Reference Books:

1. Rafael Gonzalez, Richard Woods, **"***Digital Image Processing***"**PearsonEducation, 3rd ed.,2017.
2. Milan Sonya, Vaclav Hlavac& Roger Boyle, "*Image Processing Analysis and Machine Vision*"Vikas PublishingHouse, Second Edition, 2001.
3. A.K. Jain, "*Digital Image Processing*" PearsonEducation, 2nd Edition, 2004.

Course Outcomes:

At the end of course student will be able to

1. To understand the digitization, segmentation shape representation ofimages.
2. Have the basic knowledge of data structure for imageprocessing.
3. To apply these concepts on image transforms and imageenhancement.
4. Also analyze image data compression on different image representationtechniques.
5. To apply the concepts on 3D vision, geometry andradiometry.

Rajani Bisht Jakhtani

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PEC-II (NET 425)	**Optical Communications**	**3L:1T:0P**	**4 credits**

Overview of optical fiber communication-The general system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory transmission, Optical fiber Modes and configuration, Mode theory for circular Waveguides, Step Index fibers, Graded Index fibers.

Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index. Fiber Material and its Fabrication Techniques

Signal distortion in optical fibers-Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses. Information capacity determination, Group delay, Attenuation Measurements Techniques,

Types of Dispersion - Material dispersion, Wave-guide dispersion, Polarization mode dispersion, Intermodal dispersion. Pulse broadening. Overall fiber dispersion in Multi-mode and Single mode fibers, Fiber dispersion measurement techniques, Nonlinear effects. Optical fiber Connectors: Joints, Couplers and Isolators.

Optical sources-LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product.

Laser Diodes- Basic concepts, Classifications, Semiconductor injection Laser: Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, resonant frequencies, reliability of LED & ILD

Source to fiber power launching – Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling. Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors. Optical receiver operation- Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of error, Quantum limit, Analog receivers

Link Design-Point to Point Links, Power Penalities, Error control, Multichannel Transmission Techniques, WDM concepts and component overview, OTDR and optical Power meter

TEXT BOOKS:

1. John M. Senior, "*Optical Fiber Communications*", 3rd Edition, PEARSON, 2010.
2. 2. Gerd Keiser, "*Optical Fiber Communications*", 4th Edition, TMH, 2008.

REFERENCE BOOKS

1. Govind P. Agrawal, "*Fiber Optic Communication Systems*", 3rd Edition, John Wiley, 2004.
2. Joseph C. Plais, "*Fiber Optic Communication*", 4th Ed,Pearson Education, 2004.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
2. To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors.
3. To learn the various optical source materials, LED structures, quantum efficiency, Laser diodes.
4. To learn the fiber optical receivers such as PIN APD diodes, noise performance in photo detector, receiver operation and configuration.
5. To learn the fiber optical network components, variety of networking aspects, FDDI, SONET/SDH and operational principles WDM.

Rajani Bisht Jakhtani Vishal Khare

PEC-II (NET 427)	Opto-Electronics	3L:1T:0P	4 credits

Wave Nature of Light Conceptual Overview: Wave Equation, Refractive index, group and phase velocity, Pointing vector, Snell's law, Fresnel's equations, Optical Resonators, Optical Tunnelling, Coherence, Diffraction

Optical communication systems and devices needs: Optical fiber, Optical waveguides, Optical amplifiers, Optical sources, Optical detectors. Light Emitting Diodes (LED)- Science and engineering of light emitting diodes

Stimulated Emission Devices&Photo-detectors: Stimulated Emission Devices - Laser Diodes, Vertical Cavity Surface Emitting Lasers (VCSELs), Quantum well devices, Semiconducting Laser Amplifiers.Photo-detectors-PN junction, photodiode science and operation, avalanche and heterojunction photodiodes, phototransistors, photoconductive gain, CCD and CMOS sensors, sensing and imaging in different electromagnetic spectrum.

Polarization and Modulation of light&Display devices: Polarization and Modulation of light - Polarization, propagation in anisotropic media, birefringent devices, integrated optical modulators, acousto-optic modulators, magneto-optic modulators, nonlinear effects.Display devices -LCD and LED display devices, three-dimensional and light-field displays, MOEMS and MEMS displays.

Photovoltaic Devices&Optical computing: Photovoltaic Devices -Solar energy spectrum, device principles, I-V characteristics, equivalent circuit, temperature effects, materials, devices, and efficiencies. Optical computing -Implementing different mathematical functions and processors with opto-electronics.

Textbook:

1. S. O. Kasap, "*Optoelectronics and Photonics: Principles and Practices"*, Prentice Hall, 2001.
2. Shun Lien Chuang , "*Physics of optoelectronic devices*", Wiley, 1995.
3. John Wilson and John Hawkes, "*Optoelectronics, an introduction*", 3rd Edition Prentice Hall, , 1998.
4. J. Singh, "*Optoelectronics: An introduction to materials and devices*, McGraw-Hill, 1996.
5. P. N. Prasad, "*Nanophotonics*", John Wiley & Sons, 2004.

Reference Book:

1. G. P. Agrawal, "*Fiber optics communication system*", John Wiley & Sons, 2011.
2. Saleh and Teich, "*Fundamentals of Photonics"*, 2nd ed. Wiley Inter-science,2007.
3. S. L. Chuang, "*Physics of Photonic Devices"*, 2nd ed. Wiley,2009.
4. Yariv and P. Yeh, "*Photonics: Optical electronics in Modern Communications*", 6th ed. Oxford University Press, 2007.
5. D. Birtalan and W. Nunley, "*Optoelectronics: Infrared-Visible-Ultraviolet Devices and Applications*", 2nd ed., CRC Press, 2009.

Course Outcomes:

1. Verify various theoretical concepts learned in the lecture class
2. Understand how the fundamental concepts affect the performance of practical optoelectronic devices
3. Learn measurement techniques to characterize optoelectronic devices
4. Understand the basic optoelectronics including electromagnetism, light propagation in waveguides, light amplification and detection, lasers, modulators, and detectors.
5. Be familiar with recent trends in optoelectronics.

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PEC-III (NET441)	**Embedded Systems**	**2L:0T:2P**	**3 credits**

Introduction: Embedded systems and its applications, Embedded Operating system, Design parameters of an embedded system and its significance, design life cycle, tools introduction, hardware and software partitioning and co-design

Hardware Fundamentals for the embedded developer's Digital circuit parameters- Open collector outputs Tristate outputs I/O sinking and Sourcing, PLD's, Watchdog Timers, Hardware design and development.

Custom Single Purpose Processors: Optimizing program, FSMD, Data path & FSM. General purpose processors and ASIP's (Application Specific Instruction set Programming): Software and operation of general purpose Processors-Programmers, View Development Environment-ASIPs Microcontrollers-DSP Chips.

Introduction to Microcontrollers and Microprocessors: Embedded versus external, memory devices, CISC and RISC processors, Harvard and Von Neumann Architectures.

8051 Microcontrollers: Assembly language, architecture, registers, addressing modes, Instruction set, I/O ports and memory organization Interrupts Timer/counter, and serial communication.

RTOS: Tasks, states, Data, Semaphores and shared data, Operating system, services, Message queues, Mailboxes.

Advanced Processor: (only architectures) 80386, 80486 and ARM (References) Communication basics: Microprocessor Interfacing, I/O Addressing, Direct memory access, Arbitration, multilevel bus architecture, Serial protocols, Parallel Protocols and wireless protocols.

Real world Interfacing: LCD, Stepping Motor, ADC, DAC, LED, Push Buttons, Key board, Latch Interconnection, PPI.

One project based on advance microcontroller.

LIST OF EXPERIMENTS:

Note: At least 08 experiments are to be performed from the following.

1. Introduction to MSP430 launch pad and Programming Environment.
2. Read input from switch and Automatic control/flash LED (soft-ware delay).
3. Interrupts programming example using GPIO.
4. Configure watchdog timer in watchdog & interval mode.
5. Configure timer block for signal generation (with given frequency).
6. Read Temperature of MSP430 with the help of ADC.
7. Test various Power Down modes in MSP430.
8. PWM Generator.
9. Use Comparator to compare the signal threshold level.
10. Speed Control of DC Motor
11. Master slave communication between MSPs using SPI.
12. Networking MSPs using Wi-Fi

TOOL REQUIREMENT: Code Composer Studio Version 6, MSP430 based launch pads, Wi-Fi booster pack.

Text Books:

1. Frank Vahid /Tony Givargis, John Willey, "*Embedded System Design*" Willey, 2005
2. Ajay V Deshmukh, "*Microcontroller (Theory and Applications)*" . Tata McGrawHill, 2005.
3. David E. Simon, "*An Embedded Software Primer*" Pearson Education Limited, 2013

Reference Books:

1. Muhammad Ali Mazidi and Janice Gillispie, "*8051 Microcontroller and Embedded Systems*" Second Edition, 2008.
2. Kenneth Hintz, Daniel Tabak, "*Microcontrollers (Architecture, Implementation and Programming)*" TMH, 2005.
3. Lecturers of NPTEL.

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

1. Understand the basic of hardware fundamentals about embedded systems.
2. Learn about microprocessor and microcontroller.
3. Have the knowledge of interfacing from microprocessors using different techniques.
4. Apply these concepts to understand different advance processor.
5. Apply the concepts to solve real world problems.

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PEC-III (NET443)	**VLSI Design Verification And Testing**	**3L:0T:0P**	**3 credits**

Design: Introduction, Introduction to Digital VLSI Design Flow, High Level Design Representation, Transformations for High LevelSynthesis

Scheduling, Allocation and Binding: Introduction to HLS:Scheduling,Allocation and Binding Problem, Scheduling Algorithms, Binding and Allocation Algorithms

Logic Optimization and Synthesis: Two level Boolean LogicSynthesis, Heuristic Minimization of Two-LevelCircuits, Finite State Machine Synthesis, Multilevel Implementation

Verification: Binary Decision Diagram: Binary Decision Diagram: Introductionand construction, Ordered Binary Decision Diagram, Operations on Ordered Binary DecisionDiagram, Ordered Binary Decision Diagram forSequential Circuits

Temporal Logic: Introduction and Basic Operations onTemporal Logic, Syntax and Semantics of CLT, Equivalence between CTLFormulas

Model Checking: Verification Techniques Model Checking Algorithm, Symbolic Model CheckingTest; Introduction to Digital Testing: Introduction to Digital VLSI Testing, Functional and Structural Testing, Fault Equivalence

Fault Simulation and TestabilityMeasures: Fault Simulation, Testability Measures (SCOAP)

Combinational Circuit Test PatternGeneration: Introduction to Automatic Test PatternGeneration (ATPG) and ATPG Algebras, D-Algorithm
Sequential Circuit Testing andScan ChainsATPG for Synchronous SequentialCircuits, Scan Chain based SequentialCircuit Testing

Text/Reference Books:

1. D. D. Gajski, N. D. Dutt,A.C.-H. Wu and S.Y.-L. Lin, "*High Level Synthesis: Introduction to Chip and System Design*", Springer, 1st edition, 1992.
2. S.Palnitkar, "*Verilog HDL:A Guide to Digital Design and Synthesis*",Prentice Hall, 2nd edition, 2003.
3. G. De Micheli. "*Synthesis and optimization of digital circuits*", 1st edition, 1994.
4. M. Huth and M. Ryan, "*Logic in Computer Science modeling and reasoning about systems*", Cambridge University Press, 2nd Edition, 2004.
5. Bushnell and Agrawal, "*Essentials of Electronic Testing for Digital, Memory & Mixed-Signal Circuits*", Kluwer Academic Publishers, 2000.

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
1. Analysis of VLSI designs flow.
2. Analyze Boolean logic optimization and synthesis.
3. Apply the concept of different binary decisions.
4. Understand different model checking algorithm.
5. Understand the concepts for combinational and sequential testing.

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PEC-III (NET445)	**Biomedical Signal Processing**	**2L:0T:2P**	**3 credits**

Introduction to Bio-Medical Signals: Classification, Acquisition and Difficulties during Acquisition, Basics of Electrocardiography, Electroencephalography, Electromyography, & electro-retinography, Role of Computers in the Analysis, Processing, Monitoring & Control and image reconstruction in bio-medicalfield.

ECG: Measurement of Amplitude and Time Intervals, QRS Detection (Different Methods), ST Segment Analysis, Removal of Baseline Wander and Power Line Interferences, Arrhythmia Analysis, Portable Arrhythmia Monitors.

Data Reduction: Turning Point algorithm, AZTEC Algorithm, Fan Algorithm, Huffman and Modified Huffman Coding, Run Length Coding

EEG: Neurological Signal Processing, EEG characteristic, linear prediction theory, Sleep EEG, Dynamics of Sleep / Wake transition. Study of pattern of brain waves, Epilepsy- Transition, detection and Estimation

EEG Analysis by Spectral Estimation: The Bt Method, Period gram, -Maximum Entropy Method & AR Method, Moving Average Method. The ARMA Methods, Maximum LikelihoodMethod.
EP Estimation: by Signal Averaging, Adaptive Filtering: - General Structures of Adaptive filters, LMS Adaptive Filter, Adaptive Noise Canceling, Wavelet Detection: - Introduction, Detection by Structural features, Matched Filtering, Adaptive Wavelet Detection, Detection of OverlappingWavelets

LIST OF EXPERIMENTS:
Note: At least 08 experiments are to be performed from the following.
Signal data files: Available for free downloading at
http://people.ucalgary.ca/~ranga/enel563/SIGNAL DATA FILES
Laboratory Exercise: Matlab-based computer laboratory exercise for two to three hours each

1.**Acquisition of ECG and EMG Signals** (Objectives • Acquire the electrocardiogram (ECG) with and without noise at different heart rates. • Acquire the electromyogram (EMG) at different levels of muscular contraction (force).
2.**Analysis of the Relationship Between Parameters of the EMG Signal and Muscular Force**(Objectives • To characterize the level of activity in EMG signals. • To study the relationship between parameters of the EMG signal and muscular force.)
3.**Frequency-domain Analysis of Biomedical Signals** (Objectives • To study methods for frequency-domain analysis of biomedical signals. • To study the frequency content of ECG, EEG, EMG, and PCG signals.)
4.**Filtering of the ECG for the Removal of the 60 Hz Power-line Artifact**(Objective • Rejection of 60 Hz power-line interference from ECG signals.
5.Filtering of the ECG for the Removal of Noise (Objectives • Removal of high-frequency noise. • Removal of low-frequency noise (baseline artifact). • Rejection of power-line interference).
6.**Detection of the QRS and Parameterization of the ECG** (Objectives • To detect QRS complexes in ECG signals using the Pan–Tompkins algorithm. • To measure parameters of the ECG for analysis of the heart rate and cardiac rhythm)
7.**Detection of Spike-and-wave Complexes in EEG Signals** (Objectives • Detection of spike-and-wave complexes in EEG signals using template matching. • Design and implementation of a matched filter to detect spike-and-wave complexes in EEG signals.
8. **Frequency-domain Analysis of Heart Sounds** (Objectives • Segmentation of phonocardiographic (PCG) signals. • Computation of an averaged power spectral density (PSD) of a segment of a PCG signal. • Parametric characterization of PSDs. • Auditory analysis of heart sounds).
9.**Morphological Analysis and Pattern Classification of ECG Signals** (Objectives • Filter and remove artifacts in ECG signals. • Detect, segment, and extract discriminative features from QRS

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complexes in ECG signals for the characterization of normal beats and premature ventricular contractions (PVCs). • Classify ECG beats (waveforms) into two groups: normal and PVC).

10. **Wiener Filtering of ECG Signals** (Objectives • Filter and remove artifacts in ECG signals. • Design a Wiener filter using the autocorrelation function (ACF) and power spectral density (PSD) functions of ECG signals and noise. • Compare the performance of the Wiener filter with other time-domain and frequency-domain filters).

Text Books:

1. Willis J Tomkin,"*Biomedical Digital Signal Processing*", PHI, 2004.
2. D.C Reddy, "*Biomedical Signal Processing*",McGrawHill Education, 2005.
3. Cropwell, Weibeland Pfeifer,"*Biomedical Instrumentation and Measurement*", PHI, 1973.

Reference Book:

1. Amon Cohen, "*Biomedical Signal Processing*", volume I CRCPress, 1986.
2. Rangaraj M. Rangayyan, "*Biomedical Signal Analysis a Case Study Approach*", John Wiley and SonsInc, 2015.
3. John G. Webster, "*Medical Instrumentation Application and Design*", John Wiley & SonsInc.,2009.
4. Lecturers ofNPTEL.
5. R. M. Rangayyan, "Biomedical Signal Analysis," Second Edition, IEEE Press and Wiley, New York, NY. 2015

Course Outcomes:

At the end of course student will be able

1. To understand about basic biomedical signals and dataanalysis.
2. To get the information about different measuring instrument forbiomedical.
3. To apply these concepts on ECG and EEG and differentalgorithm.
4. To analyze EEG Analysis and spectral estimation.
5. To have the knowledge on EPestimation.

Rajani Bisht Jakhtan Vishal Khare

PEC-III (NET447)	**Wireless Communication**	**3L:0T:0P**	**3 credits**

Introduction to mobile communication systems, Comparison of wireless systems and trends. Cellular concept and system design fundamentals, channel assignment strategies, Hand-off strategies. Interference and system capacity. Improving capacity in cellular systems.

Mobile radio propagation, Ground reflection model, diffraction sculpturing, Indoor propagation models, outdoor propagation models, ray tracing and site specific signalling

Modulation techniques for mobile radio, diversity, Multipath fading using Rayliegh and Rician PDF, Flat fading and frequency selective fading, fading effects due to Doppler spread, speech coding, channel coding.

RAKE Receiver multiple access techniques for mobile communication, capacity ofcellularsystems

Multiple access techniques, FDMA, TDMA, CDMA

Wireless systems and standards.GSM, IS-95, 3G (IMT-2000, UMTS, 4G (WIMAX)

Introduction to wireless networking Development of wireless network, wireless data services, Mobile Satellite communication, Common channel signaling.

Protocols for network access network databases

Text/Reference Books:

1. T.S. Rappaport, "*Wireless Communication - Principles and practices*", 2Ed. Pearson Education India, 2010.
2. Mischa Schwartz, "*Mobile Communication*", Cambridge UniversityPress, 2005
3. William Stallings, "*Wireless Communications and Networks",* 2Ed.Pearson,2004.
4. Leonard Korowajczuk, Bruno Desouza, Abren Xavier and ArlindoMorieiraFartes, "*Designing CDMA 2000 Systems*", Wiley, 2004.
5. Diakoumis, Gerakoulis, Evaggelos, "*CDMA Access and Switching for Terrestrial and Satellite Networks*", 1st edition. Wiley, 2001.

Course Outcomes:

At the end of course student will be able to

1. An understanding of the requirements of modern wireless communication systems
2. An understanding of key enabling technologies including Spread Spectrum, CDMA, Equalization, Diversity etc.
3. Ability to understand the infrastructure for developing mobile Communication System Cellular Theory.
4. An understanding of implementation of the key enabling techniques in commercial wireless systems such as UMTS, HSPA and LTE.
5. An appreciation of evolving trends leading to a vision of future heterogeneous wireless communication systems.

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PEC-III (NET449)	**Radio Frequency Integrated Circuit (RFIC)**	**3L:0 T:0P**	**3 credits**

Introduction to Communications Circuits: lower frequency analog design and microwave design versus radio frequency integrated circuit design, impedance levels &units for microwave and low-frequency analogdesign.
Issues in RFIC Design- noise, thermal noise, available noise power, available power from antenna, filtering issues.

Impedance Matching- Review of the smith chart, impedance matching, conversions between series and parallel resistor-inductor and resistor-capacitor circuits, tapped capacitors and inductors, matching using transformers, the bandwidth of an impedance transformationnetwork, quality factor of an LC resonator, transmission lines, S, Y, and Z parameters.

LNA Design- Introduction and basic amplifiers, amplifiers with feedback, noise in amplifiers, linearity in amplifiers, differential pair (emitter-coupled pair) andother differential amplifiers, low-voltage topologies for LNAs and the useof on-chip transformers, DC bias networks, temperature effects.

Mixer- Mixing with nonlinearity, basic mixer operation, controlled transconductance mixer, double-balanced mixer, mixer noise, linearity, improving isolation&moore mixer.

Voltage-Controlled Oscillators- Specification of oscillator properties, LC resonator, adding negative resistance through feedback to the resonator, popular implementations of feedback to the resonator, configuration of the amplifier, basic differential oscillator topologies, oscillator amplitude, phase noise, tunable oscillator.

Text Books

1. John Rogers&Calvin Plett, "*Radio Frequency Integrated Circuit Design*", Second Edition, Artech House, 2010.
2. Reinhold Ludwig and Powel Bretchko, "*RF Circuit Design – Theory and Applications*", First Edition, Pearson Education Asia, 2000.

Reference Books:

1. Joseph J. Carr, "*Secrets of RF Circuit Design*", McGraw HillPublishers, Third Edition
2. Jon B. Hagen, "*Radio Frequency Electronics*", Cambridge university press, Cambridge.
3. James Hardy, "*High Frequency Circuit Design*", Resto Publishing Co., NewYork.
4. Ian Hickman, "*RF Hand Book*", Butter Worth Heinemann Ltd., Oxford.

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

1. Understand the importance of RFIC and its issues.
2. Apply the concept of impedance matching on different RF circuits.
3. Design of different amplifier circuit.
4. Use of mixers in RF circuits.
5. Design different oscillator.

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PEC-IV

PEC-IV (NET461)	System-on-Chip (SoC) Design	2L:1T:0P	3 credits

Methodologies and tools for System-on-Chip (SoC) and hardware/software co-design and co-verification:Hardware/software, co-design: partitioning, real-time scheduling, and hardware acceleration.

Virtual prototyping: electronic system-level languages and hardware/software co-simulation.

High-level synthesis: allocation, scheduling and binding algorithms for C-to-RTL synthesis.

SoC integration: SoC communication architectures, IP interfacing, verification and test;FPGA prototyping of hardware/software systems.

TEXT/REFERENCE BOOKS:

1. P. Marwedel, "*Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems*", Third Edition, Springer, 2018.
2. D. C. Black, J. Donovan, B. Bunton, A. Keist, "*System C: From the Ground Up*", Second Edition, Springer, 2010.
3. G. De Micheli, "*Synthesis and Optimization of Digital Circuits*", McGraw-Hill, 1994.
4. NPTEL Lectures.

COURSE OUTCOMES:

Upon completion of the course, the students should be able to

1. Analyze the functional and nonfunctional performance of the system early in the design process to support design decisions.
2. Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.
3. Analyze tradeoffs and explore architecture and microarchitecture design spaces to develop and synthesize custom hardware accelerators
4. Understand hardware, software, and interface synthesis.
5. Understand issues in interface design.

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PEC-IV (NET463)	**Adaptive Systems**	**2L:1T:0P**	**3 credits**

Discrete random processes: (i) Random variables, random processes, filtered random processes; (ii) Ensemble averages, correlation, covariance, power spectrum, cross power spectrum (iii) Ergodicity, time averages, biased & unbiased estimators, consistent estimators.

Linear prediction: Direct form linear prediction filtering; Normal equations for linear prediction filtering; Linear prediction lattice filtering

Digital Wiener filtering: Wiener smoothing and prediction filters; Application of Wiener smoothing to noise cancelling; Application of Wiener prediction filters; Constrained, linear MMSE filtering; Minimum variance beam forming

Least mean squares adaptive filter: LMS adaptive algorithm; Properties of LMS adaptive filter; Normalized forms; Finite precision effects; Adaptive beam forming.

Least squares adaptive filters: Godard algorithm, Lattice; Other adaptive filtering technique i.e Neural networks and multi-layer perceptron, Adaptive IIR filtering, The constant modulus algorithm.

Text Books:

1. S.Haykin, "*Adaptive Filter Theory*", 5th edition, Prentice-Hall, 2013.
2. Ali H. Sayed, "*Fundamentals of Adaptive Filtering*", John Wiley, 2003.

Reference Books:

1. D.Manolakis, V.Ingle, S.Kogan, "*Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing*", McGrawHill, 1999.
2. JOHN J. SHYNK, *"Probability, Random Variables, and Random Processes: Theory and Signal Processing Applications",* Published by John Wiley & Sons, Inc., Hoboken, New Jersey, 2013

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. To understand the discrete random processes.
2. Have the knowledge of linear prediction and filtering.
3. To apply the concepts of Wiener smoothing to noise cancelling and Wiener prediction for filtering.
4. Analyze least mean squares adaptive filtering using different techniques.
5. Apply the concepts of Least squares adaptive filters.

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PEC-IV (NET465)	Satellite Communication	2L:1T:0P	3 credits

Introduction& Orbital Mechanism: History of Satellite Communications, Some Basic Communications Satellite System Definitions, Regulatory Process for Satellite Communications, Kepler's Laws, Orbital Parameters, Orbits in Common Use, Geometry of GSO Links- range, elevation angle, azimuth angle & sample calculation.

Satellite Subsystems: Satellite Bus- physical structure, power subsystem, altitude controls, orbital controls, thermal control, & tracking, telemetry, command and monitoring. Satellite payload-transponder and antenna.

Satellite Link Design: Transmission fundamentals- EIRP, PFD, antenna gain, free space path loss, basic link equation of received power. System noise- noise figure, noise temperature, system noise temperature, figure of merit. Link performance parameters- Carrier-to-Noise Ratio, Carrier-to-Noise Density, Energy-Per-Bit to Noise Density. Link Considerations, Uplink, Downlink, Percent of Time Performance Specifications

Propagation Effects Modeling&Multiple Access Techniques: Atmospheric Gases, Clouds and FogRain Attenuation, Depolarization, Tropospheric Scintillation, FDMA, Calculation of C/N, TDMA, Bits, Symbols and Channels, TDMA Frame Structure, Synchronization in TDMA Networks, Satellite Switched TDMA, DAMA, FDMA-SCPC-DA, Random Access, CDMA, Spread Spectrum Transmission and Reception.

Direct Broadcast Satellite Television and Radio, Satellite Navigation, GPS: Introduction to Digital DBS TV, System Design, Satellite Radio Broadcasting, Introduction to Satellite Navigation and Global Positioning System and modern applications and developments.

Text Books:

1. Pratt, T, Bostian, C.W. and Allnutt, J. E. "*Satellite Communications*", 2nd Ed.John Wiley and Sons, 2003.
2. Louis J. Ippolito, Jr., "*Satellite Communications Systems Engineering*", 1st Ed. John Wiley and Sons, 2008.

Reference Books:

1. Ha, Tri T., "*Digital Satellite Communications*", Macmillan PublishingCompany, 1986.
2. Richharia, M., "*Mobile Satellite Communications*", Pearson Education, 2001.
3. Roddy, D., "*Satellite Communication*", Prentice Hall (India), 1982.
4. D.C. Agarwal, "*Satellite Communication*", Khanna Publishing, PHI, 2004.
5. Raja Rao, K. N., "*Fundamentals of Satellite Communication*", PrenticeHall (India), 2004.
6. R.N. Mutagi. "*Satellite communication: principles and application*", oxford.
7. Lectures of NPTEL

Course Outcomes:

At the end of course student will be able to

1. To understand the basic components of orbital mechanism, launching and satellite.
2. To understand about the satellite subsystems.
3. To solve the satellite link design numerical problems.
4. To analyze this knowledge on different multiple access technique like FDMA, TDMA, etc.
5. To understand the mechanism used for broadcasting and navigation and have the knowledge of GPS.

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PEC-IV (NET469)	Sensor Technology	3L:0T:0P	3 credits

Introduction to Electronics Measurement and Instrumentation: Transducers and sensors-Accuracy and precisions, types of errors, statistical analysis, probability of errors, limiting errors, sensitivity, linearity, hysteresis, resolution, reproducibility, transfer function.

Self-generating Sensors or active sensors Thermoelectric Sensors: Thermocouples, Thermo electric effects, Common thermocouples, Practical thermocouple laws, Cold junction compensation in thermocouples circuits. Piezoelectric Sensors: Piezoelectric effect, piezoelectric materials, applications.

Velocity and Acceleration Measurement: Relative velocity – Translational and Rotational velocity measurements – Revolution counters and Timers – Magnetic and Photoelectric pulse counting stroboscopic methods. Accelerometers-different types, Gyroscopes-applications. Density measurements – Strain Gauge load cell method – Buoyancy method – Air pressure balance method – Gamma ray method – Vibrating probe method.

Temperature Sensors: Resistance Vs Temperature characteristics for different materials, Thermistors, Thermocouples - thermoelectric effects for thermocouples, thermocouple tables, RTD, Other Thermal Sensors.

Calibration andInterfacing: Calibration using Master Sensors, Interfacing of Force, Pressure, Velocity, Acceleration, Flow, Density and Viscosity Sensors, Variable Frequency Drive

Text Books:

1. Miles Eron, "*Measurement Systems – Applications and Design*", Clanrye InternationaL, 2015.
2. Patranabis D, "Principles *of Industrial Instrumentation* ",McGraw-Hill Education - Europe
3. Clarence W De Silva, "*Sensor Systems: Fundamentals and Applications*", Taylor & Francis, CRC Press.

Reference Books:

1. Curtis D. Johnson, "*Process Control Instrumentation Technology*", Prentice Hall India.
2. D.V.S. Murty, "*Transducers and Instrumentation*", Prentice Hall India.
3. Helfrick Albert D. and Cooper W. D., "*Modern Electronic Instrumentation and Measurement Techniques*", Prentice Hall India.
4. Kalsi H. S. "*Electronic Instrumentation*", Tata McGraw-Hill Education.
5. Shawhney A. K. "*A Course In Electrical and Electronics Measurements andInstrumentation*",DhanpatRai& Sons, 11th Ed., 1999.
6. Bell David A. "*Electronic Instrumentation and Measurements*", PHI / Pearson Education.
7. Mathew Sadiku, "Elements of Electromagnetics", PHI

Course Outcomes:

1. After completion of the course the student is able to:
2. Identify suitable sensors and transducers for real time applications.
3. Translate theoretical concepts into working models.
4. Design the experimental applications to engineering modules and practices.
5. Design engineering solution to the Industry/Society needs and develop products.

Rajani Bisht

Jakhtan

Vishal Khare

PEC-V

PEC-V (NET422)	**VLSI Implementation of Digital Signal Processing Algorithms**	**3L:1T:0P**	**4 credits**

Introduction to Digital Signal Processing Systems and Iteration Bound; Typical DSP Algorithms, DSP Application Demands and Scaled CMOS, Technologies, Representations of DSP Algorithms, Data-Flow Graph Representations, Loop Bound and Iteration Bound, Algorithms for Computing Iteration Bound, Iteration Bound of Multirate Data-Flow Graphs, Conclusions, Problems.

Pipelining and Parallel Processing; Introduction, Pipelining of FIR Digital Filters, Parallel Processing, Pipelining and Parallel Processing for Low Power, Conclusions, Problems.

Retiming; Introduction, Definitions and Properties, Solving Systems of Inequalities, Retiming Techniques, Conclusions, Problems.

Unfolding and Folding; Introduction, An Algorithm for Unfolding, Properties of Unfolding, Critical Path, Unfolding, and Retiming, Applications of Unfolding, Conclusions, Problems, Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding of Multirate Systems, Conclusions, Problems.

Algorithmic Strength Reduction in Filters and Transforms; Introduction, Parallel FIR Filters, Discrete Cosine Transform and Inverse DCT, Parallel Architectures for Rank-Order Filters, Conclusions, Problems.

Text Books:

1. Keshab K. Parhi, "*VLSI Digital Signal Processing Systems-Design and Implementations*" John Wiley & Sons, Inc.
2. Keshab K. Parhi and Takao Nishitani "*Digital Signal Processing for Multimedia Systems*", Marcel Dekker Inc.

Reference Books:

1. Sen M. Kuo and Woon-seng S. Gan, "*Digital Signal Processors-Architectures, Implementations and Applications*" Pearson Education, Inc.
2. Rulph Chassaing, "*Digital Signal Processing and Applications with the C6713 and C6416 DSK*".
3. J. G. Chung and Keshab K. Parhi, Kluwer, "*Pipelined Lattice and Wave Digital Recursive Filters*".

Course Outcomes:

On completion of the course, student will be able to:

1. Represent the signal flow graph, data flow graph and dependence graph of DSP algorithms.
2. Apply the pipelining and parallel processing to speed up the DSP algorithms.
3. Apply the concept of retiming the DSP algorithms for trade off the speed and power.
4. Apply the concepts unfolding and folding the DSP algorithms.
5. Apply the algorithmic Strength Reduction to lead a reduction in hardware complexity by exploiting substructure sharing.

Rajani Krishna Jakhtani Vishal Khare

PEC-V (NET424)	**Network Science**	**3L:1T:0P**	**4 credits**

Networks appearing in different fields: Technological networks, Social Networks, Network of information, Biological Network;
Milgram's small world experiment (6 degrees of separation), Properties of real world networks and their physical interpretation,
Influence in social networks, strength of weak ties, modeling economic systems, community detection in networks,
modeling the spread of epidemics in human networks, centrality measures and their applications, webgraphs, Navigation on networks.

TEXT BOOK:

1. Mark Newman, "*Networks: An Introduction*", Oxford University Press, 1st Ed.
2. Albert-Laszlo Barabasi, "*Network Science*", Cambridge University Press, 1st Ed.

REFERENCE BOOK:

1. Matthew O. Jackson, "*Social and Economic Networks*", Princeton University Press, 1st Ed.
2. David Easley, Jon Kleinberg , "*Networks, Crowds, and Markets: Reasoning about a Highly Connected World*", Cambridge University Press, 1st Ed.
3. Edward L. Platt, "*Network Science with Python and NetworkX Quick Start Guide: Explore and visualize network data effectively*", Packt Publishing Limited, 1st Ed.

Course Outcome:

1. Identify the network underlying real life phenomena.
2. Able to handle real World Network Datasets.
3. To understand the importance of a particular node and link in the network.
4. To find out existing communities in the network.
5. To understand and model the diffusion of information over the network.

Rajani Bisht Jakhtani Vishal Khare

PEC-V (NET426)	Micro Electronic Mechanical Systems (MEMS)	3L:1T:0P	4 credits

Introduction& Review: Intrinsic Characteristics of MEMS- Miniaturization, Microelectronics Integration, Mass Fabrication with Precision, Sensors and Actuators- Energy Domains and Transducers, Sensors, Actuators.Introduction to Micro fabrication:The Microelectronics Fabrication Process, Silicon based MEMS processes, New Materials and Fabrication Processes, Points of Consideration for Processing. Review of Essential Electrical and Mechanical Concepts- Conductivity of Semiconductors, Crystal Planes and Orientation, Stress and Strain, Flexural beam bending analysis under simple loading conditions, Torsional deflections.

Sensing & Actuation: Electrostatic Sensing and Actuation-Introduction to Electrostatic Sensors and Actuators, Parallel-Plate Capacitors, Applications of ParallelPlate Capacitors, Interdigitated Finger Capacitors, Applications of CombDrive Devices.Thermal Sensing and Actuation-Introduction, Sensors and Actuators Based on Thermal Expansion, Thermal Couples, Thermal Resistors, Applications. Magnetic Actuation-Essential Concepts and Principles, Fabrication of Micromagnetic Components, Case Studies of MEMS Magnetic Actuators.

Piezoresistive &Piezoelectric: Piezoresistive Sensors- Piezoresistive Sensor Materials, Stress Analysis of Mechanical Elements, Applications of Piezoresistive Sensors. Piezoelectric Sensing and Actuation- Introduction, Properties of Piezoelectric Materials, Applications.

Micromachining & Etching: Bulk Micromachining and Silicon Anisotropic Etching-Introduction, Anisotropic Wet Etching, Dry Etching of Silicon-Plasma Etching, Deep Reactive Ion Etching (DRIE), Isotropic Wet Etching, Gas-Phase Etchants, Native Oxide, Wafer Bonding, Case Studies. Surface Micromachining-Basic Surface Micromachining Processes, Structural and Sacrificial Materials, Acceleration of Sacrificial Etch, Stiction and AntiStiction Methods, Assembly of 3D MEMS, Foundry Process.

Polymer &Optical MEMS: Polymer MEMS-Introduction, Polymers in MEMS-Polyimide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene, Fluorocarbo, Representative Applications-Acceleration Sensors, Pressure Sensors, Flow Sensors, Tactile Sensors. Optical MEMS-Passive MEMS Optical Components-Lenses, Mirrors, Actuators for Active Optical MEMS Actuators for Small Out-of-Plane Translation, Actuators for Large In-Plane Translation Motion, Actuators for Out-of-Plane Rotation.

Text Books

1. Chang Liu, *Foundations of MEMS*, Pearson Education Inc., 2012.
2. Stephen D Senturia, *Microsystem Design*, Springer Publication, 2000.
3. Tai Ran Hsu, *MEMS & Micro systems Design and Manufacture*, McGraw-Hill education, 2002.

Reference Books

1. James J.Allen, "*Micro Electro Mechanical System Design*", CRC Press Publisher, 2010
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "*Micro Sensors MEMS and Smart Devices*", Wiley, 2002
3. Mohamed Gad-el-Hak, editor, *The MEMS Handbook*, CRC press Baco Raton, 2000
4. Nadim Maluf, *An Introduction to Micro Electro Mechanical System Design*, Artech House, 2000.
5. Thomas M.Adams and Richard A.Layton, *Introduction MEMS, Fabrication and Application*, Springer 2012.
6. Lectures of NPTEL
7. E-resources (https://www.me.iitb.ac.in/~gandhi/me645/05L1_coursecontents_mtvn.pdf)

Rajani Bisht Jakhtan Vishal Khare

Course Outcomes:

1. Understand the operation of micro devices, micro systems and their applications
2. Apply scaling laws that are used extensively in the conceptual design of micro devices and systems
3. Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process
4. Simplify the design of micro devices, micro systems using the MEMS fabrication process
5. Understood the design considerations on various physical parameters

Rajani Bisht Jakhtan Vishal Khare

OEC-1

OEC-I (OET301)	**Analog Circuits**	**2L:0T:0P**	**2 credits**

Biasing: Significance of biasing, DC Biasing of BJT and MOSFET, Stability Factor, Small Signal model of BJT and MOSFET.

Amplifiers: Significance and principles of Amplifiers, emitter follower, Analysis of Single Stage CS, CG & CD (MOSFET Amplifiers) .

Feedback and stability: Significance and importance of Feedback network, The General Feedback Structure, Properties of Negative Feedback, and Effect of Negative Feedback. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, concept of stability.

Power Amplifiers: Significance of power amplifiers, Classification of Output Stages; Class A, Class B, Class AB, Class C amplifier: Circuit Operation, Signal Waveforms / Transfer Characteristic, Power Dissipation and Power-Conversion Efficiency.

Oscillators and Waveform-Shaping Circuits: Introduction to OscillatorsBark-Heusen criteria,Hartley & Colpitts Oscillators, Crystal Oscillators; Multivibrators: Basic circuit and operation concept of Astable Multivibrator, Monostable Multivibrator and Bistable Multivibrator using timer, and its practical application

Text Books:

1. Boylestad, Robert &Nashelsky, Louis / "*Electronic Devices & Circuit Theory*" / Pearson Education India, 11th Edition 2015.
2. Shilling, D. H. &Belove, Ch. / "*Electronic Circuit*"/ McGraw-Hill International.
3. Malvino, A.P., Bates.D.J, Hoppe P.E "*Electronics Principles*" 9th Ed. McGraw-Hill, 2021
4. Sedra, Adel S., Smith, Kenneth C. / "*Microelectronic Circuits*"/ Oxford University Press, 5th, 2012.

Reference Books:

1. Bell, David A. / "*Electronic Devices & Circuits*"/ Prentice-Hall (India).
2. Millman, J. and Grabel, A. / "*Microelectronics*"/ McGraw –Hill.
3. Nair, B. Somanathan/ "*Electronic Devices & Applications*"/ Prentice-Hall (India)
4. Neamen, Donald A. / "*Electronic circuit Analysis &Design*" / Tata McGraw Hill
5. Schaum's Outlines / "*Electronic Devices & Circuits*"/ Tata McGraw Hill
6. Lectures of NPTEL, Razavi.

Course outcomes:

After the completion of syllabus student will be able to:

1. Analyze the concept of biasing its effect on circuit operation
2. Design, analysis and implementation of the amplifier circuit.
3. Feedback and different amplifiers in mid-band and high frequency region.
4. Analyze the principle of regulated DC power supply and oscillator.
5. Implement and test the circuits related with signal generator (oscillators) and signal shaping.

Rajani Bisht Jakhtani Vishal Khare

OEC-I (OET303)	**System Design using MATLAB**	**2L:0T:0P**	**2 credits**

Introduction: (i) Basic of MATLAB, Types of Window, Types of File, Basic Operations, **(ii) Matrix (Array Design):** Matrix Operation, Array Design, Array Operation, Multidimensional Array,

Graphics and Operators: Plotting, Multiple Plot, 2-D Plot, 3-d Plot, Subplot, Handle Graphics, Animation, Example(like a project); **Operators:** Arithmetic Operator, Logical, Relational

Branch, Loop, Script and Function: If statement, If-else statement, Else-if statement, Pause,Break,Continue,Switch-case,try-catch,Return Statement, For Loop,While Loop, Example(like a project); **Script and Function:** Script Design, Function Design, Types Of Function, Example(like a project)

Simulink: Introduction Of Simuling, Study of Library, Circuit Oriented Design, Equation Oriented Design, Connectivity, Model, Subsystem Design, Connect Call back to subsystem

Application: **Ordinary Differential Equations (Types, Solutions & Examples),** System Design in MATLAB Using System Objects: Create Individual Components, Configure Components, Assemble Components Into System, Run the System

Text / Reference Books -

1. Alexandre M. Bayen and Timmy Siauw/ "*An Introduction to MATLAB*$^{(R)}$ *Programming and Numerical Methods for Engineers"*/ Academic Press 2014.
2. Daniel T. Valentine , Brian Hahn / "*Essential MATLAB for Engineers and Scientists* 7th Edition, Elsevier 2014.

Course Outcomes:

At the end of course student will be able to

1. Understand the main features of the MATLAB integrated design environment and its user interfaces.
2. Have the basic knowledge of MATLAB commands, with an emphasis on creating variables, accessing and manipulating data in variables, and creating basic visualizations.
3. Perform mathematical and statistical calculations with vectors.
4. Perform typical data analysis tasks in MATLAB, including importing data from files, preprocessing data, fitting a model to data, and creating a customized visualization of the model.
5. Apply the concepts to create, edit, and simulate models in Simulink

Rajani Bisht Jakhtani Vishal Khare

OEC-I (OET305)	Semiconductor Devices	2L:0 T:0P	2 credits

Semiconductor Diode and its application: Intrinsic and extrinsic semiconductor materials, energy band diagram, diode construction and working, depletion region, diode equivalent circuits, rectifiers, clippers, clampers, and voltage multipliers.

Transistors:

BJT- construction and working, their current expressions, CB, CE and CC configuration and its input and output characteristics, relationship between their current gains, DC biasing in BJT.

FET- Construction and working of JFET, transfer characteristics, Depletion type MOSFET and Enhancement type MOSFET.

Operational Amplifiers & Its application: Introduction,Op-Amp Basics, Practical Op-Amp Circuits, Constant-Gain Multiplier, Voltage Summing, Voltage Buffer, Controller Sources, &Active Filters.

Feedback and Oscillators: Concept of feedback, Feedback Connection Types, Practical Feedback Circuits, Feedback Amplifier, Oscillator Operation, Phase Shift oscillators, Wien-bridge oscillator, Tuned Oscillator Circuit&Crystal oscillators.

Special Diodes: Zener Diodes, Light-Emitting Diodes (LEDs), photodiode, avalanche photo diode, tunnel diode, laser, varactor diode, schottky diode, and Gunn diode.

Text Books

1. Streetman, B.G. & Banerjee, Sanjay "*Solid State Electronic Devices*" Prentice Hall (India) 2014.
2. Millman , J., Halkias, C.& Parikh, C.D, "*Integrated Electronics*" / McGraw Hill Education , 2nd 2017.
3. Boylestad, Robert &Nashelsky, Louis, "*Electronic Devices & Circuit Theory*" Pearson Education India, 11th Edition 2015.
4. Sedra, Adel S., Smith, Kenneth C. / "*Microelectronic Circuits*"/ Oxford University Press, 5th, 2012.

Reference Books:

1. Bell, David A. / "*Electronic Devices & Circuits*"/ OUP India (Anna edition) 2010.
2. Nair, B. Somanathan/ "*Electronic Devices & Applications*"/ PHI Learning, 1st 2006
3. Nagrath, I. J. / "*Electronics, Analog & Digital*"/ PHI Learning, New Title edition, 1998
4. Neamen, Donald A. / "*Electronic Circuits-Analysis & Design*" / McGraw Hill education, 3rd, 2006.
5. Neamen, Donald A. / "*Semiconductor Physics & Devices*" /McGraw Hill education, 4th, 2017.
6. Salivahanan, S. & Kumar, Suresh N. &Vallavraj / "*Electronic Devices & Circuits*" /McGraw Hill education, 3rd , 2012.
7. Schaum's Outlines / "*Electronic Devices & Circuits*"/ McGraw Hill Education, 2nd 2002.
8. Millman, J. and Grabel, A. / "*Microelectronics*"/ McGraw Hill Education, 2nd 2017
9. Lectures of NPTEL, Razavi.

Course Outcome:

1. Basic concepts of diode and numerical solution on diode circuits.
2. Understanding of construction & working of BJT and MOSFET
3. Analyze the concept of operational amplifier.
4. Analyze the concept of feedback and oscillator.
5. Acquire the knowledge of state-of-art semiconductor diodes used in industry.

Vishal Khare

OEC-II

OEC-II (OET401)	VLSI Technology	2L:0T:0P	2 credits

Crystal Growth & Wafer Characterization: Electronic Grade Silicon, CZ Crystal, Growing, Silicon Shaping, Processing Consideration. Material Characterization

Epitaxy: Vapor Phase Epitaxy, Molecular Beam Epitaxy

Oxidation: Growth Mechanisms, Thin Oxides, Oxide Properties, Oxidation Induced Defects, oxide thickness Characterization

Lithography: Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography

Etching: Wet Chemical Etching: Silicon, SiO_2, Silicon Nitride, Polysilicon, Aluminium, GaAs;Reactive Plasma Etching (Dry)**:** Feature Size Control in Isotropic and Anisotropic, Etch Mechanisms, Reactive Plasma Etching Techniques and Equipment

Diffusion: Models of Diffusion in Solids, Fick's One Dimensional Diffusion Equations, Atomic Diffusion Mechanisms

Ion Implantation: Range Theory, Implantation Equipment, Implant damage and Annealing, Implantation related processes

Dielectric and Polysilicon Film Deposition: Deposition Processes (CVD & MBE), Poly Silicon, Silicon Dioxide, Silicon Nitride, SLow-dielectric-Constant Material, High-dielectric-Constant Material

Metallization: Metallization Applications, Metallization Choice, Physical Vapour Deposition, Chemical Vapour Deposition, Aluminium Metallization, Copper Metallization. Patterning,

Process Integration: Passive Component, Bipolar IC Technology, MOSFET Technology, MESFET Technology and MEMS Technology, Packaging

Text Books:

1. Sze, S.M./ "*VLSI Technology*" / 2nf Ed. McGraw-Hill education 2017.
2. James D. Plummer, M
3. Michael Deal, and Peter B. Griffin, / "*Silicon VLSI Technology: Fundamentals, Practice and Modelling*"/ 1st Pearson 2000.
4. Streetman, B.G. & Banerjee, Sanjay "*Solid State Electronic Devices*" Prentice Hall (India) 2014.

Reference Books:

4. Campbell, Stephen A. / "*The Science & Engineering of Microelectronic Fabrication*" 2ndOxford University Press 2012.
5. Gandhi, S. "*VLSI Fabrication Principle: Silicon and Gallium Arsenide and Fabrication*" 2ndWiley 2008
6. Lecturers of NPTEL.

Course Outcomes:

At the end of course student will be able to

6. Understand the basic process of crystal growth and different steps for fabrication of ICs
7. Understand the concept of crystal growth, epitaxy and on film deposition
8. Understand basic steps for formation of ICs like lithography, Etching, Ion implantation, Metallization.
9. Understand the process integration concept of IC Technology
10. Apply these concepts to finalized the fabrication process of different types of MOSFETs

Jakhtani Rajani Bisht Vishal Khare

OEC-II (OET403)	**Communication System**	**2L:T:0P**	**2 credits**

Introduction: Elements of communication systems, review of signal representations in time and frequency domain, bandwidth, filters, Electromagnetic spectrum, Sky waves, ground waves and space waves, Antenna fundamentals and types of antennas.

Analog Modulation Techniques: DSB, DSB-SC, SSB-SC, VSB, expression and their demodulation techniques,Angle modulation- Frequency modulation, NBFM and WBFM, Phase modulation, Radio receivers block diagram.

Pulsed and Digital modulation techniques: Sampling theorem, nyquist criteria, PAM, PWM, PPM modulation, quantization and pulse code modulation (PCM), DPCM, DM, ADM, digital modulation techniques- ASK, FSK & PSK modulation and demodulation process.

Fundamentals of Medias: Guided and unguided media, wave guides, twisted pair cable, coaxial cables, fiber optic cables- snells law, principle of working, modes of optical fiber, cable types and specifications.

Case studies: FM Broadcast, satellite communication, telephone systems, mobile telephony.

Text Books:

1. J. G. Proakis & M. Salehi, "*Communication Systems Engineering*", 2nd Edition, Pearson Education, 2002.
2. Haykin, Simon, "*Communication Systems*", John Wiley, 2013.
3. Haykin, Simon / "*Communication Systems*" / John Wiley
4. Kennedy, G. & Davis, B. "*Electronic Communication Systems*" 6th McGraw-Hill Education 2017.

Reference Books:

1. Simon Haykin / "*Digital Communication*" / John Wiley.
2. Taub& Schilling / "*Principles of Communication Systems*" / Tata McGraw-Hill
3. Singh, R. P. &Sapre, S.D. / "*Communication Systems: Analog & Digital*" / Tata McGraw-Hill.
4. Lathi, B.P / "*Modern Digital & Analog Communication Systems*" / Oxford University
5. Singh, R.P. and Sapre, S.D. "*Communication Systems: Analog & Digital*" 3rd Ed. McGraw- Hill Education 2017.
6. Proakis J.J. "*Digital Communications*", McGraw Hill, 2000.
   a. Schaum's Outlines / "Analog & Digital Communication" / Tata McGraw-Hill.
7. Lectures of NPTEL

Course Outcomes:

At the end of course student will be able to

1. To understand the basic of signals in time and frequency domain.
2. Comparative study of various schemes for analog modulation and demodulation for different applications
3. Analyze and compare different digital modulation schemes for their efficiency and bandwidth.
4. To learn about different media.
5. Apply communication system in different application.

Rajani Bisht Jakhtani Vishal Khare

OEC-II (OET405)	Integrated Cicuits	2L:0T:0P	2 credits

The 741 IC Op-Amp: General operational amplifier stages (bias circuit, the input stage, the second stage, the output stage, short circuit protection circuitry), device parameters, DC and AC analysis of input stage, second stage and output stage, gain, frequency response of 741, a simplified model, slew rate.

Linear Applications of IC Op-Amps: Op-Amp based V-I and I-V converters, instrumentation amplifier, generalized impedance converter, simulation of inductors, Active analog filters: first and second order low pass, high pass, band pass and band stop filter, all pass active filters, KHN Filters.

Non-Linear Applications of IC Op-Amps: Basic Log–Anti Log amplifiers using diode and BJT, temperature compensated Log-Anti Log amplifiers using diode, peak detectors, sample and hold circuits, Op-amp as a comparator and zero crossing detector, astablemultivibrator, monostablemultivibrator, generation of triangular waveforms, analog multipliers and their applications.

Digital Integrated Circuit Design: An overview, CMOS logic gate circuits basic structure, CMOS realization of inverters, AND, OR, NAND and NOR gates, Latches and Flip flops: the latch, CMOS implementation of SR flip-flops, a simpler CMOS implementation of the clocked SR flip-flop, CMOS implementation of J-K flipflops, D flip- flop circuits.

D/A Converters: Binary weighted resistor and R-2R ladder, A/D converters: dual slope, successive approximation type and flash converter. Integrated Circuit Timer: Timer IC 555 pin and functional block diagram, Monostable and Astablemultivibrator using the 555 IC. Phase Locked Loop (PLL): Basic principle of PLL, block diagram, working, Ex-OR gates and multipliers as phase detectors, applications of PLL.

Text Book:

1. Sedra and Smith,Arun N. Chandorkar "*Microelectronic Circuits*", Sixth Edition, Oxford, 2013.

Reference Books:

1. Gayakwad : *Op-Amps and Linear Integrated Circuits* , 4 th edition Prentice Hall of India, 2002.
2. Michael Jacob, "*Applications and Design with Analog Integrated Circuits*", PHI, 2 nd Edition, 2004
3. Salivahnan, *Electronics Devices and Circuits*, McGraw-Hill Education, 2nd Edition, 2015
4. Millman , J., Halkias, C.& Parikh, C.D / "Integrated Electronics" / McGraw Hill Education , 2^{nd} 2017.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Students will be able to gain in-depth knowledge of complete analysis of Op-Amp 741-IC.
2. Students will acquire knowledge about Op-Amp based circuits and basic components of ICs such as various types of filters.
3. Students will be able to understand the concept of Op-Amp based non-linear and wave- shaping circuits.
4. Students will learn about CMOS digital integrated circuits and digital memory circuits.
5. Students will gain knowledge about the working principle of data converters along with application specific ICs such as 555 timer and PLL.

Rajani Bisht Jakhtani Vishal Khare

OEC-III

OEC-III (OET402)	Satellite Communication	2L:0T:0P	2 credits

Introduction& Orbital Mechanism: Some Basic Communications Satellite System Definitions, Kepler's Laws, Orbital Parameters, Orbits in Common Use, calculation of range, elevation angle, and azimuth.

Satellite Subsystems: Satellite Bus- physical structure, power subsystem, altitude controls, orbital controls, thermal control, & tracking, telemetry, command and monitoring. Satellite payload- transponder and antenna.

Satellite Link Design: Transmission fundamentals- EIRP, PFD, antenna gain, free space path loss, basic link equation of received power. System noise- noise figure, noise temperature, system noise temperature, figure of merit. Link performance parameters- Carrier-to-Noise Ratio, Carrier-to-Noise Density, Energy-Per-Bit to Noise Density.

Multiple Access Techniques: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), CDMA, Spread Spectrum Transmission and Reception.

Direct Broadcast Satellite Television and Radio, Satellite Navigation, GPS: Introduction to Digital DBS TV, System Design, Satellite Radio Broadcasting, Introduction to Satellite Navigation and Global Positioning System and modern applications and developments.

Text Books:

3. Pratt, T, Bostian, C.W. and Allnutt, J. E. "*Satellite Communications*", 2nd Ed.John Wiley and Sons, 2003.

4. Louis J. Ippolito, Jr., "*Satellite Communications Systems Engineering*", 1st Ed. John Wiley and Sons, 2008.

Reference Books:

1. Ha, Tri T., "*Digital Satellite Communications*", Macmillan PublishingCompany, 1986.
2. Richharia, M., "*Mobile Satellite Communications*", Pearson Education, 2001.
3. Roddy, D., "*Satellite Communication*", Prentice Hall (India), 1982.
4. D.C. Agarwal, "*Satellite Communication*", Khanna Publishing, PHI, 2004.
5. Raja Rao, K. N., "*Fundamentals of Satellite Communication*", PrenticeHall (India), 2004.
6. R.N. Mutagi. "*Satellite communication: principles and application*", oxford.
7. Lectures of NPTEL

Course Outcomes:

At the end of course student will be able to

1. To understand the basic components of orbital mechanism, launching and satellite.
2. To understand about the satellite subsystems.
3. To solve the satellite link design numerical problems.
4. To analyze this knowledge on different multiple access technique like FDMA, TDMA, etc.
5. To understand the mechanism used for broadcasting and navigation and have the knowledge of GPS.

Jakhtan Rajani Bisht Vishal Khare

OEC-III (OET404)	**Mobile Communication**	**2L:0T:0P**	**2 credits**

Introduction: Introduction to Mobile Computing, Applications of Mobile Computing, Generations of Mobile Communication Technologies, MAC Protocols, SDMA, TDMA, FDMA, CDMA

Mobile Telecommunication System: GSM, Architecture, Protocols, Connection Establishment, Frequency Allocation, Routing, Mobility Management, Security, GPRS, UMTS, Architecture

Wireless Networks: Wireless LANs and PANs, IEEE 802.11 Standard , Architecture, Services, Blue Tooth, Wi-Fi, WiMAX

Mobile Network Layer: Mobile IP, DHCP , AdHoc, Proactive and Reactive Routing Protocols, Multicast Routing, Vehicular Ad Hoc networks (VANET) ,MANET Vs VANET, Security

Mobile Transport And Application Layer: Mobile TCP, WAP, Architecture, WDP, WTLS, WTP, WSP, WAE, WTA Architecture, WML

Text Books:

1. Schiller,J. "*MobileCommunication*"/ Pearson Education/ 2^{nd}Ed. 2008

Reference Books:

1. Richharia, M., "*Mobile Satellite Communications*", Pearson Education, 2001
2. Lee, W.C.Y. "*Mobile Communication Engineering*"/2^{nd} Ed. McGraw-Hill Education
3. Gibson, J.D. "*Mobile CommunicationHand Book"* 3^{rd} Ed. CRC Press 2017
4. Feher, Kamilo "*Wireless Digital Communications*" 1^{st} Pearson Education India 2015.

Course Outcomes:

At the end of course student will be able to

1. To understand the techniques involved in mobile communication.
2. To review MAC, satellite and broadcast system.
3. Analyze architecture of mobile associated systems.
4. Have the in depth knowledge of network and transport layer.
5. To understand various systems that support for mobility.

Rajani Bisht Jakhtan Vishal Khare

OEC-III (OET 406)	Network Science	2L:0T:0P	2 credits

Networks appearing in different fields: Technological networks, Social Networks, Network of information, Biological Network;
Milgram's small world experiment (6 degrees of separation), Properties of real world networks and their physical interpretation,
Influence in social networks, strength of weak ties, modeling economic systems, community detection in networks,
modeling the spread of epidemics in human networks, centrality measures and their applications, webgraphs, Navigation on networks.

TEXT BOOK:

1. Mark Newman, "*Networks: An Introduction*", 1st Ed Oxford University Press 2010.
2. Albert-Laszlo Barabasi, "*Network Science*", 1st Ed Cambridge University Press, 2016.

REFERENCE BOOK:

1. Matthew O. Jackson, "*Social and Economic Networks*",1st Ed. Princeton University Press 2010.
2. David Easley, Jon Kleinberg , "*Networks, Crowds, and Markets: Reasoning about a Highly Connected World*", 1st Ed Cambridge University Press,2010.
3. Edward L. Platt, "*Network Science With Python and NetworkX Quick Start Guide: Explore And Visualize Network Data Effectively*", 1st Ed. Packt Publishing Limited, 2019.

Course Outcome:

1. Identify the network underlying real life phenomena.
2. Able to handle real World Network Datasets.
3. To understand the importance of a particular node and link in the network.
4. To find out existing communities in the network.
5. To understand and model the diffusion of information over the network.

K gaurav 16/2/23
(Dr. Kumar Gaurav)
Assistant Professor

12/2/23
(Dr. Nand Kishore)
Assistant Professor

Rajani Bisht
(Dr. Rajani Bisht)
Professor

(Dr. Ashutosh Singh)
Professor

(Dr. K. Raj)
Professor

(Shri Amit Kumar)
Member BoS

Vishal Khare
(Shri Vishal Khare)
Member BoS

(Prof. S. Wairya)
Member BoS

Jakhtar
(Prof. M. J. Akhtar)
Member BoS

(Prof. M. K. Meshram)
Member BoS

16/02/2023
(A. K. Shankhwar)
Professor & Head