NATIONAL INSTITUTE OF TECHNOLOGY MEGHALAYA

Department of Electronics and Communication Engineering

Under Graduate

Curriculum & Syllabus

Regulation – 2018 Onwards

B.Tech in Electronics and Communication Engineering

CONTENTS

Department of Electronics and Communication Engineering

Vision

A Centre of Excellence in Knowledge and Technological Innovation Research-Hub in the field of Electronics and Communication Engineering by creation of a skilled manpower to meet the Local, National, and Global needs of Industry and Society.

Mission

1. Provide Quality Education in the field of Electronics and Communication Engineering.
2. Impart Research & Training on cutting edge technologies on VLSI, Signal Processing and Communication for Societal issues.
3. Promote Competitive Academic Programmes through Industry Relevant skills that support Entrepreneurial Growth and Industry Ready.
4. Strengthening Moral values and Ethics with Managerial, skills to become Technocrats and Entrepreneurs.

Program Educational Objectives (PEOs)

PEO1	Ensure practicing Electronics and Communication Engineers contribute to industry or academia in contemporary and multidisciplinary issues using appropriate EDA tools in a responsible, professional, social, economical and ethical manner including safety and environmental concerns.
PEO2	Engage innovation and creativity in product development by imparting knowledge, skills and engineering solutions.
PEO3	Encourage effective life-long learning approaches on new development of technologies by updating skills and knowledge to succeed in industry/higher education research.
PEO4	Apply teamwork and leadership qualities with effective communication in the multidisciplinary field that support the overall development of the nation and the world.

Program Specific Outcomes (PSOs)

PSO1	Graduates will be able to achieve excellence in the fields of VLSI, Signal Processing and Communications related Engineering disciplines by acquiring the knowledge in basic science, mathematics, circuit design, signal processing to develop the technologically innovative systems.
PSO2	Graduates build their professional career by acquiring expertise on EDA tools, concepts and knowledge in emerging multidisciplinary fields with managerial, entrepreneurial skills to become team players, leaders, Technocrats and Entrepreneurs.
PSO3	Graduate will acquire adequate theoretical and practical knowledge of Electronics and Communication Engineering knowledge to comprehend, analyze, design and create innovative solutions for Research and Development , Industry and societal requirements,
PSO4	Encourage graduates to become good human beings and responsible citizens for the overall welfare of the society with a global outlook.

Program Outcomes (POs)

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

Structure of Curriculum

SEMESTER - 1							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
MA101	Differential Calculus and Linear Algebra	Sc/HS	3	1	0	4	None
ME101	Engineering Mechanics	BE	3	0	0	3	None
CY101/ PH101	Chemistry/Physics	Sc/HS	2/3	1	0	3/4	None
CE101	Engineering Drawing	BE	1	0	4	3	None
EE101/ EC101	Basic Electrical Engineering/ Basic Electronics Engineering	BE	2	0	0	2	None
HS101	English Language Skills	Sc/HS	2	0	0	2	None
HS151	English Language Skills Lab	L	0	0	2	1	None
CY151/ PH151	Chemistry/Physics Lab	L	0	0	2	1	None
EE151/ EC151	Basic Electrical Lab/ Basic Electronics Lab	L	0	0	2	1	None
Total Contact Hours – Component wise			13/14	2	10		
Total Contact Hours			**25/ 26**			**20/21**	---

SEMESTER - 2							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
MA102	Integral Calculus and Complex Variables	Sc/HS	3	1	0	4	None
EE101/ EC101	Basic Electrical Engineering/ Basic Electronics Engineering	BE	2	0	0	2	None
PH101/ CY101	Physics /Chemistry	Sc/HS	3/2	1	0	4/3	None
CY102	Environmental Science	Sc/HS	2	0	0	2	None
CS102	Introduction to Computing	Sc/HS	2	1	0	3	None
ME 102	Workshop Practice	L	0	0	4	2	None
EE151/ EC151	Basic Electrical Lab/Basic Electronics Lab	L	0	0	2	1	None
PH151	Physics Lab	L	0	0	2	1	None
CS152	Computing Lab	L	0	0	2	1	None
Total Contact Hours – Component wise			12/11	3	10		
Total Contact Hours			**25/24**			**20/19**	---

SEMESTER - 3							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
MA 201	Integral Transforms and PDEs	M	3	1	0	4	None
Professional Core Courses - 1, 2, 3							
EC 201	Electronic Devices	PC	3	1	0	4	EC 101
EC 203	Digital Logic Design	PC	3	1	0	4	None
EC 205	Network Analysis & Synthesis	PC	3	0	0	3	None
Special Course – 1							
ME 291	Safety Engineering	S	2	0	0	2	None
Lab Courses - 1, 2, 3							
EC 251	Electronic Devices Lab	L	0	0	2	1	None
EC 253	Digital Logic Design Lab	L	0	1	2	2	None
EC 255	Network Analysis & Synthesis Lab	L	0	1	2	2	None
Total Contact Hours – Component wise			**14**	**5**	**6**	22	
Total Contact Hours			**25**			**22**	---

SEMESTER - 4							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
Professional Core Courses - 4, 5, 6							
EC 202	Signals and Systems	PC	3	1	0	4	None
EC 204	Electronic Circuits	PC	3	1	0	4	EC 101
EC 206	Microprocessors and Microcontrollers	PC	3	0	0	3	None
Professional Elective – 1							
EC 210	Power Electronics	PE	3	0	0	3	None
EC 212	Probability Theory and Stochastic Processes	PE	3	0	0	3	None
EC 214	Python Programming for Electronic Engineers	PE	3	0	0	3	None
Professional Elective – 2							
EC 220	Electronic Measurement & Instrumentation	PE	3	0	0	3	None
EC 222	Data Structures & Algorithms	PE	3	0	0	3	None
EC 224	Computer Architecture	PE	3	0	0	3	None
Open Elective - 1							
EC 272	Operational Amplifiers and Its Applications	OE	2	0	0	2	None
Lab Courses - 4, 5, 6							
EC 252	Signals and Systems Lab	L	0	1	2	2	None
EC 254	Electronic Circuits Lab	L	0	0	2	1	None
EC 256	Microprocessors and Microcontrollers Lab	L	0	1	2	2	None
Total Contact Hours – Component wise			**17**	**4**	**6**	24	
Total Contact Hours			**28**			**24**	**---**

SEMESTER - 5							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
Professional Core Courses - 7, 8, 9							
EC 301	Analog and Digital Communication	PC	3	1	0	4	None
EC 303	Electromagnetic Waves and Radiating Patterns	PC	3	1	0	4	None
EC 305	Digital Signal Processing	PC	3	0	0	3	None
Professional Elective - 3							
EC 311	Embedded Systems	PE	3	1	0	4	None
EC 313	Sensors and Transducers	PE	3	1	0	4	None
EC 315	Biomedical Instrumentation	PE	3	1	0	4	None
Professional Elective – 4							
EC 321	Linear Integrated Circuits	PE	3	0	0	3	None
EC 323	Image Processing	PE	3	0	0	3	None
EC 325	Statistical Communication Theory	PE	3	0	0	3	None
Open Elective – 2							
EC 371	Micro-Sensor Technology	OE	2	0	0	2	None
Lab Courses - 7, 8, 9							
EC 351	Analog and Digital Communication Lab	L	0	1	2	2	None
EC 353	Electromagnetic Waves and Radiating Patterns Lab	L	0	1	2	2	None
EC 355	Digital Signal Processing Lab	L	0	0	2	1	None
Total Contact Hours – Component wise			**17**	**5**	**6**	25	
Total Contact Hours			**28**			**25**	---

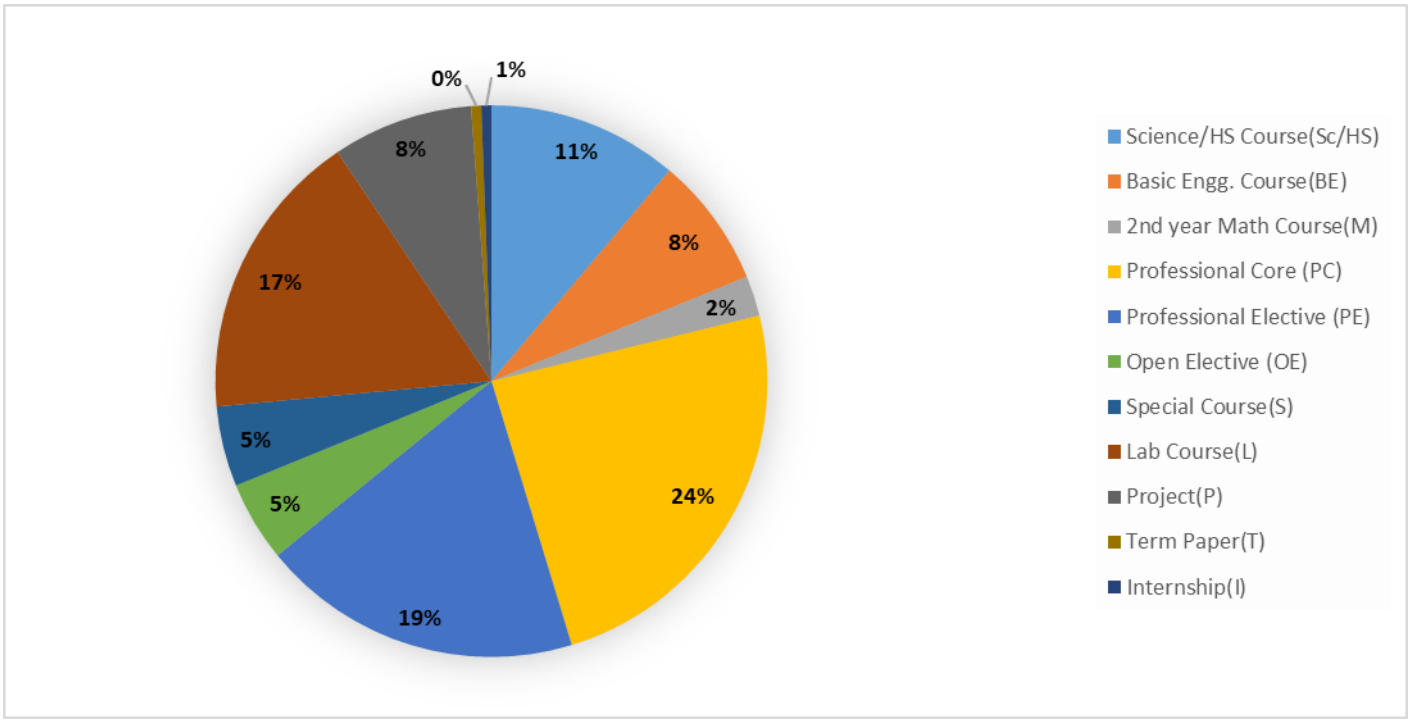
SEMESTER - 6							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
Professional Core Courses – 10, 11							
EC 302	Digital and Analog Integrated Circuits	PC	3	1	0	4	None
EC 304	RF & Microwave Engineering	PC	3	1	0	4	None
Professional Elective – 5							
EC 310	Artificial Neural Networks & Applications	PE	3	1	0	4	None
EC 312	Fundamentals of Microwave Antenna &Propagation	PE	3	1	0	4	None
EC 314	Data Communication and Networks	PE	3	1	0	4	None
Professional Elective – 6							
EC 320	Control Systems	PE	3	0	0	3	None
EC 322	Advanced Digital Signal Processing	PE	3	0	0	3	None
EC 324	DSP Systems & Architectures	PE	3	0	0	3	None
Open Elective – 3							
EC 372	Basics of Communication systems	OE	2	0	0	2	None
EC 374	Designing IoT Platform with Arduino & Pi	OE	2	0	0	2	None
Special HS Course – 2							
HS 392	Corporate Communication	S	2	0	0	2	None
Lab Courses – 10, 11							
EC 352	Digital and Analog Integrated Circuits Lab	L	0	1	2	2	None
EC 354	RF & Microwave Engineering Lab	L	0	1	2	2	None
EC 382	Term Paper	T	0	0	2	1	None
Total Contact Hours – Component wise			**16**	**4**	**6**	24	
Total Contact Hours			**26**			**24**	---

SEMESTER – 7							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
EC 401	Project – I	P	0	0	10	5	None
Professional Elective –7							
EC 411	VLSI Design	PE	3	0	0	3	None
EC 413	Biomedical Image Processing	PE	3	0	0	3	None
EC 415	Wireless Communication	PE	3	0	0	3	None
EC 417	High Band Gap Device Modelling	PE	3	0	0	3	None
Professional Elective –8							
EC 421	VLSI Signal Processing	PE	3	0	0	3	None
EC 423	Machine Learning and Speech Technology	PE	3	0	0	3	None
EC 425	CAD for VLSI Design	PE	3	0	0	3	None
EC 427	Satellite Communication	PE	3	0	0	3	None
Open Elective –4							
EC 473	Fundamentals of Image and Video Processing	OE	2	0	0	2	None
EC 475	Basics of VLSI	OE	2	0	0	2	None
Special Course –3							
CE491	Disaster Management	S	2	0	0	2	None
Lab Courses – 12							
EC 451	Computing & Simulation Lab	L	0	1	2	2	None
EC 481	Summer Internship	I	0	0	0	1	
Total Contact Hours – Component wise			**10**	**1**	**12**	18	
Total Contact Hours			**23**			**18**	---

SEMESTER - 8							
Course Code	**Course Title**	**Course Type**	**Contact Hours**			**Credit**	**Pre-requisites**
			L	**T**	**P**	**C**	
EC 402	Project - II	P	0	0	18	9	None
Professional Elective –9							
EC 410	Introduction to MEMS	PE	3	0	0	3	None
EC 412	Wideband Communication	PE	3	0	0	3	None
EC 414	Radar Engineering	PE	3	0	0	3	None
EC 416	Digital Arithmetic Circuits	PE	3	0	0	3	None
EC 418	Pattern Recognition and Applications	PE	3	0	0	3	None
Professional Elective –10							
EC 420	Advanced Semiconductor for RF and Power Application	PE	3	0	0	3	None
EC 422	Low Power VLSI	PE	3	0	0	3	None
EC 424	Internet of Things	PE	3	0	0	3	None
EC 426	Fiber Optics Communication	PE	3	0	0	3	None
EC 428	Statistical Signal Analysis	PE	3	0	0	3	None
EC 440	Information Theory and Coding	PE	3	0	0	3	None
Special Course –4							
HS 492	Entrepreneurship	S	2	0	0	2	None
Total Contact Hours – Component wise			**8**	**0**	**18**	17	
Total Contact Hours			**26**			**17**	---

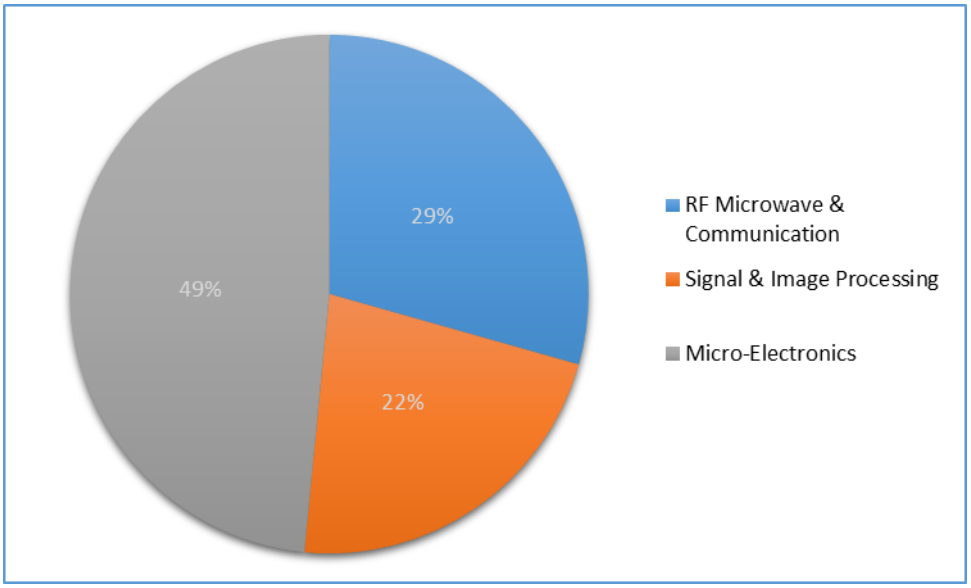
Credit Distribution (Course Components)

Category	Sem - 1	Sem - 2	Sem - 3	Sem - 4	Sem - 5	Sem - 6	Sem - 7	Sem - 8	Total
Science/HS Course (Sc/HS)	**9/10**	**10/9**							**19**
Basic Engg. Course(BE)	**8**	**5**							**13**
2nd year Math Course(M)			**4**						**4**
Professional Core (PC)			**11**	**11**	**11**	**8**			**41**
Professional Elective (PE)				**6**	**7**	**7**	**6**	**6**	**32**
Open Elective (OE)				**2**	**2**	**2**	**2**		**8**
Special Course(S)			**2**			**2**	**2**	**2**	**8**
Lab Course(L)	**3**	**5**	**5**	**5**	**5**	**4**	**2**		**29**
Project(P)							**5**	**9**	**14**
Term Paper(T)						**1**			**1**
Internship(I)							**1**		**1**
Total	**20/21**	**20/19**	**22**	**24**	**25**	**24**	**18**	**17**	**170**



Credit Distribution (Research Components)

Research Group	Sem - 1	Sem - 2	Sem - 3	Sem - 4	Sem - 5	Sem - 6	Sem - 7	Sem - 8	Total
RF Microwave & Communication	**0**	**0**	**5**	**3**	**15**	**16**	**6**	**12**	**57**
Signal & Image Processing	**0**	**0**	**0**	**9**	**11**	**7**	**10**	**6**	**43**
Micro-Electronics	**3**	**0**	**11**	**24**	**13**	**14**	**14**	**15**	**94**
Total	**3**	**--**	**16**	**36**	**39**	**37**	**30**	**33**	**194**



List of Professional Core Courses

Sl.NO	Course Code	Course Name	Credits
1	EC 201	Electronic Devices	4
2	EC 203	Digital Logic Design	4
3	EC 205	Network Analysis & Synthesis	3
4	EC 202	Signals and Systems	4
5	EC 204	Electronic Circuits	4
6	EC 206	Microprocessors and Microcontrollers	3
7	EC 301	Analog and Digital Communication	4
8	EC 303	Electromagnetic Waves and Radiating Patterns	4
9	EC 305	Digital Signal Processing	3
10	EC 302	Digital and Analog Integrated Circuits	4
11	EC 304	RF & Microwave Engineering	4

List of Professional Electives

Sl.NO	Course Code	Course Name	Credits
1	EC 210	Power Electronics	3
2	EC 212	Probability Theory and Stochastic Processes	3
3	EC 214	Python Programming for Electronic Engineers	3
4	EC 220	Electronic Measurement & Instrumentation	3
5	EC 222	Data Structures & Algorithms	3
6	EC 224	Computer Architecture	3
7	EC 311	Embedded Systems	4
8	EC 313	Sensors and Transducers	4
9	EC 315	Biomedical Instrumentation	4
10	EC 321	Linear Integrated Circuits	3
11	EC 323	Image Processing	3
12	EC 325	Statistical Communication Theory	3
13	EC 310	Artificial Neural Networks & Applications	4
14	EC 312	Fundamentals of Microwave Antenna &Propagation	4
15	EC 314	Data Communication and Networks	4
16	EC 320	Control Systems	3
17	EC 322	Advanced Digital Signal Processing	3
18	EC 324	DSP Systems & Architectures	3
19	EC 411	VLSI Design	3
20	EC 413	Biomedical Image Processing	3
21	EC 415	Wireless Communication	3
22	EC 417	High Band Gap Device Modelling	3
23	EC 421	VLSI Signal Processing	3
24	EC 423	Machine Learning and Speech Technology	3
25	EC 425	CAD for VLSI Design	3
26	EC 427	Satellite Communication	3
27	EC 410	Introduction to MEMS	3
28	EC 412	Wideband Communication	3
29	EC 414	Radar Engineering	3
30	EC 416	Digital Arithmetic Circuits	3
31	EC 418	Pattern Recognition and Applications	3
32	EC 420	Advanced Semiconductor for RF and Power Application	3
33	EC 422	Low Power VLSI	3
34	EC 424	Internet of Things	3
35	EC 426	Fiber Optics Communication	3
36	EC 428	Statistical Signal Analysis	3
37	EC 440	Information Theory and Coding	3

List of Open Electives

Sl.NO	Course Code	Course Name	Credits	Offered by
1	EC 272	Operational Amplifiers and Its Applications	2	
2	EC 371	Micro-Sensor Technology	2	
3	EC 372	Basics of Communication systems	2	
4	EC 374	Designing IoT Platform with Arduino & Pi	2	
5	EC 473	Fundamentals of Image and Video Processing	2	
6	EC 475	Basics of VLSI	2	

List of Special Courses

Sl.NO	Course Code	Course Name	Credits	Offered by
1	ME 291	Safety Engineering	2	
2	HS 392	Corporate Communication	2	
3	CE491	Disaster Management	2	
4	HS 492	Entrepreneurship	2	

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	Electronics and Communication Engineering	Semester	**I/I I**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 101	**Basic Electronics**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	To develop the student's ability to apply the basic principles ofelectronics in circuit analysis.	Course Outcomes	CO1	Verify the V-I characteristics of p-n junction diode, schottky diode, zener diode (Voltage Regulation), LED and study of rectifier and filtering Circuits.
	To develop the student's ability to design basic circuits based on diode,transistor and digital logic ICs.		CO2	Study the characteristics and switching action of BJT in CE, CB andCC mode.
	To provide the students with some knowledge and analysis skills associated with the principles of operation and applications of the digitalsystems.		CO3	Interpret the truth tables of logic gates and De-Morgan's theoremsfor digital electronics circuits.
	To develop the student's ability to communicate effectively the knowledge of electronics and communication systems.		CO4	Understand about Radio Frequency Spectrum, modulation and itsapplication in transmitter and receivers.
			CO5	Explain the working of electronic instruments like Cathode Ray Oscilloscope & Digital Storage Oscilloscope, Function Generator, Power Supply, Digital Multimeter.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	-	-	-	-	-	-	-	-	-	-	**3**	-	**3**	**3**
2	CO2	**3**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	-	**2**	**3**
3	CO3	**3**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	**3**	**2**	**3**
4	CO4	**3**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	**3**	**2**	**3**
5	CO5	**3**	**2**	-	-	-	-	-	-	-	-	-	-	-	-	-	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** Fundamentals concept of semiconductor (Energy Bandgap, Mobility, Conductivity & Resistivity) and Junction(Metal-Semiconductor and Semiconductor –Semiconductor (homo and hetero-junction). **Diode and it's circuits** Basic p-n junction Diode Theory, Zener Diode, Photodiode, Light Emitting Diode, Varactor Diode, and Schottky Diode. Half Wave Rectifier Circuit, Full Wave Rectifier Circuit and Bridge Rectifier Circuit, Filtering Circuits (C, L, L-C & πfilters), Voltage Multipliers.	**07**	**CO1**
II	**Diode and it's circuits** Transistor Theory, Transistor Action, Transistor Symbols, Common Collector, Common Emitter and Common Base Configurations, Different Biasing Techniques, Concept of Transistor Amplifier.	**04**	**CO2**
III	**Digital Electronics** Boolean Algebra, Logic Gates, Combinational Circuits.	**03**	**CO3**
IV	**Communication** Introduction to Radio Frequency Spectrum, Modulation, Need of Modulation, Different Types of Modulation, BasicCircuits of Modulation and Demodulation, Transmitters and Receivers, Application of Modulation.	**06**	**CO4**
V	**Instrumentation** Cathode Ray Oscilloscope & Digital Storage Oscilloscope: Theory and Applications, Function Generator, Power Supply, Digital Multimeter.	**04**	**CO5**
	Total Hours	**24**	

Essential Readings

1. Basic Electronics, Chattopadhyay & Rakshit, New Age Publisher, 2009

Supplementary Readings

1. Electronics Principles, Albert P. Malvino, Publisher: Tata McGraw-Hill, 2010
2. Electronics Devices, Thomas L. Floyd, Publisher: Pearson Education, 2008

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	Electronics and Communication Engineering	Semester	**I/II**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINOUS EVALUATION	VIVA	Total
EC 151	Basic Electronics Engineering Lab	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives	To develop the student's ability to apply the basic principles ofelectronics in circuit designing.	Course Outcomes	CO1	Verify the V-I characteristics of p-n junction diode, schottky diode, zener diode (Voltage Regulation), LED and study of rectifier and filtering Circuits.
	To develop the student's ability to design circuits based on diode,transistor and digital logic ICs.		CO2	Study the characteristics and switching action of BJT in CE, CBand CC mode.
	To develop the student's ability to communicate effectively the knowledge of electronics and communication systems.		CO3	Interpret the truth tables of logic gates and Demorgan's theoremsfor digital electronics circuits.
			CO4	Work in teams to plan and execute the creation of complex Digitalsystems.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**3**	**-**	**3**	**3**
2	CO2	**3**	**1**	**1**	**-**	**1**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**2**	**3**
3	CO3	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**2**	**3**	**2**	**3**
4	CO4	**1**	**1**	**1**	**1**	**-**	**3**	**3**	**1**	**1**	**3**	**-**	**-**	**2**	**3**	**2**	**3**

SYLLABUS

No.	List of Experiments	Hours	COs
1.	I-V characteristics of forward biased P-N junction Diode.	12	CO1, CO2, CO3 & CO4
2.	Reverse characteristics of Zener Diode		
3.	Zener Diode as a reference Diode.		
4.	Half-wave rectifier using diode		
5.	Full-wave rectifier using diode		
6.	Bridge rectifier.		
7.	Truth Table verification of Logic Gates.		
8.	Design of basic logic gates using NAND & NOR gates		
9.	Input & output characteristics of BJT in CB mode		
10.	Input & output characteristics of BJT in CE mode		
	Total Hours	**12**	

Essential Readings

1. Basic Electronics, Chattopadhyay & Rakshit, New Age Publisher, 2009

Supplementary Readings

1. Electronics Principles, Albert P. Malvino, Publisher: Tata McGraw-Hill, 2010
2. Electronics Devices, Thomas L. Floyd, Publisher: Pearson Education, 2008

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Pre-requisite	**Basic Electronics (EC 101)**		
Department	**Electronics and Communication Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 201	**Electronics Devices**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	1. To understand the physical structure and electrical properties of semiconductor materials.	Course Outcomes	CO1	Understand the principles of semiconductor physics
	2. To master the fundamental concepts and equations of semiconductor devices.		CO2	Understand the current-voltage characteristics and mathematical models of semiconductor junction diodes, bipolar transistors, and field-effect transistors.
	3. To understand the terminal characteristics of junction diodes, bipolar transistors, and field-effect transistors.		CO3	Understand the fabrication processes involved in the manufacturing of semiconductor devices

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-
2	CO2	**3**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-
3	CO3	**3**	**2**	**3**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-

No.	Content	Hours	COs
I	***Semiconductor Physics:*** Introduction to Semiconductor Physics, Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity, Generation and recombination of carriers; Poisson and continuity equation	**8**	**CO1**
II	**Semiconductor Junction Diodes:** P-N junction characteristics, I-V characteristics, and small signal switching models; Avalanche and Zener breakdown, Zener diode, Schottky diode, LED, photodiode and solar cell.	**10**	**CO2**
III	**Bipolar Junction Transistor (BJT):** Bipolar Junction Transistor and its type, I-V characteristics, configuration types, biasing type, BJT model like Ebers-Moll Model, and small signal model.	**10**	**CO2**
IV	**Field effect transistor (JFET) & Metal Oxide Semiconductor (MOS):** Junction Field effect Transistor and its type, MOSFET and its type, I-V characteristics of MOSFET, MOS capacitor, C-V characteristics, MOSFET, I-V characteristics, and small signal models of MOS transistor,	**10**	**CO2**
V	**Fabrication Process:** Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process	**10**	**CO3**
	Total Hours	**48**	

Essential Readings

1. G. Streetman and S. K. Banerjee, “Solid State Electronic Devices”, Pearson, Seventh Edition, 2014.
2. D.A. Neamen, “Semiconductor Physics and Devices”, Tata McGraw Hill Education, Third Edition, 2007
3. C.C. Hu, “Modern Semiconductor Devices for Integrated Circuits”, Pearson, 2010.

Supplementary Readings

1. S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices”, John Wiley & Sons, Third Edition, 2006.
2. C.T. Sah, “Fundamentals of solid state electronics,” World Scientific Publishing Co. Inc, 1991.
3. Y. Tsividis and M. Colin, “Operation and Modeling of the MOS Transistor,” Oxford Univ.Press, 2011..

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 203	**Digital Logic Design**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	
	To understand the principles of Boolean logic and optimize the circuits.
	To develop the skills for modular Boolean, Arithmetic and Sequential circuits.
	To develop the student ability to design circuits using EDA tools

Course Outcomes		
	CO1	Able to understand the basic concepts of Boolean algebra and optimization of circuits.
	CO2	To design combinational and sequential circuits.
	CO3	Able to predict and analyse the behaviour of synchronous and asynchronous circuits.
	CO4	To apply the CAD tools to realize digital circuits and behaviour

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**3**
2	CO2	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**3**
3	CO3	**3**	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**2**
4	CO4	**2**	**2**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Number Systems and Codes:** Addition, Subtraction, Multiplication and Division using Different Number Systems; Representation of Binary Number in Sign-Magnitude, Sign 1's Complement and Sign 2's Complement Notation; Rules for Addition and Subtraction with Complement Representation; BCD, EBCDIC, ASCII, Extended ASCII, Gray and other Codes. **Boolean Algebra and Switching Functions:** Basic Logic Operation and Logic Gates, Truth Table, Basic Postulates and Fundamental Theorems of Boolean Algebra, Standard Representations of Logic Functions- SOP and POS Forms, Simplification of Switching Functions-K-Map and Quine-Mc- Cluskey Tabular Methods, Synthesis of Combinational Logic Circuits.	**13**	**CO1**
II	**Combinational Logic Circuits Using MSI Integrated Circuits** **Programming:** Binary Parallel Adder, BCD Adder, Encoder Priority Encoder, Decoder, Multiplexer and Demultiplexer Circuits, Implementation of Boolean Functions using Decoder and Multiplexer, Arithmetic and Logic Units, BCD-To-Segment Decoder, Common Anode and Common Cathode, 7-Segment Displays, Random Access Memory, Read Only Memory and Erasable Programmable ROMs, Programmable Logic Arrays(PLA) and Programmable Array Logic (PAL)	**08**	**CO1, CO2**
III	**Introduction to Flip-Flops:** Basic Concepts of Sequential Circuits, Cross Coupled SR Flip-Flop Using NAND or NOR Gates, JK Flip-Flop Rise Conditions, Clocked Flip-flops, D-Types and Toggle Flip-flops, Truth Tables and Excitation Tables for Flip-flop. Master Slave Configuration Edge Triggered and Level Triggered Flip-flop, Elimination of Switch Bounce using Flip-flop, Flip-flop with Pre-set and Clear.	**10**	**CO2, CO3**
IV	**Sequential Logic Circuit Design:** Introduction to State Machine, Mealy and Moore Model, State Machine Notation, State Diagram, State Table, Transition Table, Table Excitation, Table and Equation, Basic Concepts of Counters and Register, Binary Counters, BCD Counters, Up Down Counter, Johnson Counter, Module-N Counter, Design of Counter using State Diagrams and Tables, Sequence Generators, Shift Left and Right Register, Registers with Parallel Load, Serial -in-Parallel-Out(SIPO) and Parallel-In-Serial-Out(PISO), Register Using Different Types of Flip-flops Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation.	**10**	**CO3**
V	**VLSI Design flow:** Design entry: Schematic, FSM & HDL, different modelling styles in VHDL/Verilog, Data types and objects, Dataflow, Behavioural and Structural Modelling, Synthesis and Simulation VHDL/Verilog constructs and codes for combinational and sequential circuit.	**07**	**CO3, CO4**
Total Hours		**48**	

Essential Readings

1. Mano Morris, Digital Logic and Computer Design, Pearson Education, 14th ed. 2012.
2. A. Anand Kumar Fundamentals of Digital Circuits Prentice Hall India Learning, 4th ed. 2016.
3. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1st ed., 1989.
4. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill, 2nd edition, 2012.

Supplementary Readings

1. Brown S. and Zvonko Vranesic, Fundamental of Logic with Verilog Design, Tata McGraw Hill, 3rd Edition, 2013.
2. Kime Charies R and Morris Mano, Logic and Computer Design Fundamentals, Pearson Education, 4th Edition, 2013.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation: **2018-19**
Department	**Electronics and Communication Engineering**	Semester: **III**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 205	**Network Analysis and Synthesis**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To understand the fundamentals of electrical circuits		CO1	Able to acquire the knowledge about the fundamentals of electrical circuits
To understand the concepts of network theorems and resonant circuits		CO2	Able to analyse and solve problems on network theorems and resonant circuits
To analyse the two port network and network topology		CO3	Able to analyse and solve problems on two port network and network topology
To understand the concepts of network synthesis and Laplace transformation		CO4	Able to analyse and solve problems on network synthesis and Laplace transformation

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**	-
2	CO2	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**	-
3	CO3	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**	-
4	CO4	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**	-
5	CO5	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**	-

No.	Content	Hours	COs
I	***Introduction to electrical circuits:*** Electrical Circuit and Network: Concept and Terminology, Classification of electrical networks, R-L-C Parameters, Voltage and current sources, Independent and dependent sources, Source transformation, Voltage-current relationship for passive elements, Kirchhoff's laws, Network reduction techniques-Series, Parallel, Series-parallel, Star to Delta transformation, Nodal and Mesh analysis. Concept of Self and Mutual inductance, Co-efficient of coupling, Dot convention and loop analysis.	**4**	**CO1, CO2**
II	**Network theorems:** Statement and proof: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem, Reciprocity theorem, Tellegen's theorem under the dependent and independent sources for DC and AC excitation. **Resonance in AC circuits:** Characteristics and properties of resonance circuits, Series and parallel resonance circuits, Selectivity, Bandwidth and Quality factor.	**12**	**CO1, CO2**
III	**Two port networks:** Limitations Z, Y, ABCD, h-parameters, Conversion of one parameter to another parameter, Condition for reciprocity and symmetry, Two port network connections in series, parallel and cascaded. **Network topology:** Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and Loop currents, Cut-set matrix and node pair potentials, Duality and Dual networks.	**6**	**CO3**
IV	**Network Synthesis:** Synthesis vs. analysis, Elements of circuit synthesis, LL FPB networks, Purpose and scope of network synthesis. **Positive Real Functions:** Definition, Necessary and sufficient conditions for a function to be positive real, Testing of driving point functions for positive realness. **FOSTER and CAUER Forms:** Foster and cauer forms of LC Networks, Synthesis of RC and RL networks.	**8**	**CO4**
V	**Laplace transform and Transient analysis:** Advantages of Laplace transform method, Definition and basic theorems of Laplace transform, Laplace transform of some basic functions and periodic functions, Inverse Laplace transform Transient response of R-L, R-C, R-L-C networks using Laplace transform method with DC and AC excitation. Response to step, Impulse and ramp inputs.	**4**	**CO4**
	Total Hours	**34**	

Essential Readings

1. Valkenberg, "Network Analysis", Prentice-Hall of India Pvt. Ltd, 3rd Edition, 2014.
2. F. F. Kuo, "Network Analysis and Synthesis", John Wiley & Sons, 2nd Edition, 2006.
3. C. L. Wadhwa, "Network Analysis and Synthesis", New Age International Publishers, 2nd Edition, 2007.

Supplementary Readings

1. D. R. Choudhary, "Networks and Systems", New Age International, 2nd Edition, , 2013.
2. A. Chakrabarti, "Circuit Theory: Analysis and Synthesis", Dhanpat Rai & Co., 6th Edition, 2014.
3. D. E. Scott, "An Introduction to Circuit analysis: A System Approach", 1st Edition McGraw Hill, 1987.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINUOS EVALUATION	VIVA	Total
EC 251	**Electronic Devices Lab**	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives	To understand the fundamentals of electronic devices	Course Outcomes	CO1 Will develop understanding on electronic devices and TCAD tool
	To understand the concepts of junction diode and transistors		CO2 Will develop understanding on IV and CV of the junction diode
	To understand the use of TCAD tool		CO3 Will develop understanding on IV and CV of the BJT and FET

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-
2	CO2	**3**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-
3	CO3	**3**	**2**	**3**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-

SYLLABUS

No.	Content	Hours	COs
I	Introduction to the TCAD tool and its use.	**12**	**CO1, CO2, CO3**
II	Observe P-N Junction Diode Characteristics in forward and reverse bias for silicon		
III	Simulate P-N Junction Diode, LED, Photodiode Characteristics		
IV	Observe Zener Diode Characteristics in reverse bias condition		
V	Determination npn BJT input, output and transfer Characteristics		
VI	Determination pnp BJT input, output and transfer Characteristics		
VII	Determination of MOSFET input, output and transfer Characteristics		
VIII	Study about fabrication process		
Total Hours		**12**	

Essential Readings

1. G. Streetman and S. K. Banerjee, “Solid State Electronic Devices”, Pearson, Seventh Edition, 2014.
2. D.A. Neamen, “Semiconductor Physics and Devices”, Tata McGraw Hill Education, Third Edition, 2007
3. C.C. Hu, “Modern Semiconductor Devices for Integrated Circuits”, Pearson, 2010.

Supplementary Readings

1. S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices”, John Wiley & Sons, Third Edition, 2006.
2. C.T. Sah, “Fundamentals of solid state electronics,” World Scientific Publishing Co. Inc, 1991.
3. Y. Tsividis and M. Colin, “Operation and Modeling of the MOS Transistor,” Oxford Univ.Press, 2011..

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINUOS EVALUATION	VIVA	Total
EC 253	**Digital Logic Design Laboratory**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To understand the principles of Boolean logic and optimize the circuits.		CO1	Able to understand the basic concepts of Boolean algebra and optimization of circuits.
	To develop the skills for modular Boolean, Arithmetic and Sequential circuits.		CO2	To design combinational and sequential circuits.
	To develop the student ability to design circuits using EDA tools		CO3	Able to predict and analyse the behaviour of synchronous and asynchronous circuits.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**3**	**1**	-	-	-	-	-	-	-	-	**3**	-	-	-
2	CO2	**2**	**2**	-	**1**	-	-	-	-	-	-	-	-	**3**	-	-	-
3	CO3	**3**	**3**	**2**	**1**	**2**	-	-	-	-	-	-	-	**2**	**3**	-	-
4	CO4	**2**	**2**	**2**	-	**2**	**2**	-	-	-	-	-	-	**2**	**3**	-	-

SYLLABUS

No.	Content	Hours	COs
1	Implement half-adder/ half-subtractor circuits using a serial input.	**24**	**CO1, CO2, CO3**
2	Implement full-adder/ full-subtractor Circuits using a serial input.		
3	Perform 4-Bit Gray to Binary/ Binary to Gray code conversion using select input.		
4	Perform and implement logic expression with the help of **MUX IC 74153**.		
5	Implement the flip-flops using NAND/ NOR gate.		
6	Implement Excess-3 BCD adder/subtractor with select input.		
7	Implement modulo-7 ripple counter.		
8	Implement 4-bit shift left/right register.		
9	Implement the sequence generator.		
10	Verify the behaviour of logic circuits and sequential circuits using EDA tools.		
	Total Hours	**24**	

Essential Readings

1. Mano Morris, Digital Logic and Computer Design, Pearson Education, 14th ed. 2012.
2. A. Anand Kumar Fundamentals of Digital Circuits Prentice Hall India Learning, 4th ed. 2016.
3. D.V. Hall, “Digital Circuits and Systems”, Tata McGraw Hill, 1st ed., 1989.
4. Charles Roth, “Digital System Design using VHDL”, Tata McGraw Hill, 2nd edition, 2012.

Supplementary Readings

1. Brown S. and Zvonko Vranesic, Fundamental of Logic with Verilog Design, Tata McGraw Hill, 3rd Edition, 2013.
2. Kime Charies R and Morris Mano, Logic and Computer Design Fundamentals, Pearson Education, 4th Edition, 2013.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**III**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINUOS EVALUATION	VIVA	Total
EC 255	**Network Analysis and Synthesis Laboratory**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	Course Outcomes		
To understand the fundamentals of electrical circuits		CO1	Will develop understanding on electrical circuits
To understand the concepts of transient response of RLC circuits		CO2	Will develop understanding on of transient response of RLC circuits
To understand the two port network and network topology		CO3	Will develop understanding on two port network
To understand network synthesis		CO4	Will develop understanding on network synthesis
		CO5	
		CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**0**
2	CO2	**3**	**3**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**0**
3	CO3	**3**	**3**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**0**
4	CO4	**3**	**3**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**0**

SYLLABUS

No.	Content	Hours	COs
I	Verify principle of Superposition theorem with dc and ac sources.	**22**	**CO1, CO2, CO3**
II	Verify Thevenin and Norton theorems in ac circuits.		
III	Verify Maximum Power Transfer theorem in ac circuits.		
IV	Verify Reciprocity and Tellegen's theorems.		
V	Verify resonance phenomenon in RLC series circuit.		
VI	Verify resonance phenomenon in RLC parallel circuit.		
VII	Determination of self-inductance, mutual inductance and coupling co-efficient of a single-phase two winding transformer representing a coupled circuit.		
VIII	Observe the transient response of current in RL and RC circuits with step voltage input.		
IX	Observe the transient response of current in RLC circuits with step voltage input for under-damp, critically damp and over-damp cases.		
X	Determination of z and h parameters (dc only) for a network and computation of Y and ABCD parameters.		
XI	Study LC network synthesis.		
Total Hours		**22**	

Essential Readings

1. V. Valkenberg, "Network Analysis", Prentice-Hall of India Pvt. Ltd, 3rd Edition, 2014.
2. F. F. Kuo, "Network Analysis and Synthesis", John Wiley & Sons, 2nd Edition, 2006.
3. C. L. Wadhwa, "Network Analysis and Synthesis", New Age International Publishers, 2nd Edition, 2007.

Supplementary Readings

1. D. R. Choudhary, "Networks and Systems", New Age International, 2nd Edition,, 2013.
2. A. Chakrabarti, "Circuit Theory: Analysis and Synthesis", Dhanpat Rai & Co., 6th Edition, 2014.
3. D. E. Scott, "An Introduction to Circuit analysis: A System Approach", 1st Edition McGraw Hill, 1987.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	Electronics and Communication Engineering	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 202	**Signals and Systems**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To familiarize elementary ideas of signals and systems classification and their properties for both continuous-time and discrete- time cases		CO1	Able to understand and solve problems involving signals and systems that arise in broad array of applications
	To analyze the continuous and discrete linear time invariant system using impulse response		CO2	Able to represent any general signals as linear combination of impulses and characterization of any linear time invariant system using convolution sum and integral
	To represent the continuous and discrete signals in terms of Fourier series and transform		CO3	Able to apply the Fourier series and transform for analyzing of signals
	To analyze the linear time invariant system using Fourier series and transform for both continuous-time and discrete- time		CO4	Able to apply the Laplace transform and z transform for analyzing of continuous time/ discrete time signals and systems
	To analyze and investigate stability and instability of system using Laplace and Z-transforms.			

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	**2**	**1**	**1**	-	-	-	-	-	-	-	**2**	-	**1**	-
2	CO2	**2**	**2**	**2**	**1**	-	-	-	-	-	-	-	-	**2**	-	**2**	-
3	CO3	**2**	**2**	**2**	**2**	**2**	-	-	-	-	-	-	**2**	**2**	**2**	**2**	-
4	CO4	**2**	**2**	**2**	**2**	**2**	-	-	-	-	-	-	**2**	**2**	**2**	**2**	-

SYLLABUS

No.	Content	Hours	COs
I	Classification of Signals, Operation on Continuous Signals and Discrete Signals, Properties of Signals, Classification of Systems and Properties of Systems	**10**	**CO1**
II	Discrete-Time and Continuous- time LTI Systems: The Convolution, Properties of LTI systems, Convolution of Finite Sequences, Correlation of signals.	**08**	**CO2**
III	Frequency Analysis of Continuous-Time Signals, Frequency Analysis of Discrete-Time Signals, Properties of The Fourier Transformation For Continuous- time and Discrete-Time signals, Frequency Sampling Method of Designing FIR Filters.	**12**	**CO3**
IV	Frequency-Domain Characteristics of LTI Systems, Introduction of Laplace- transform,Properties of the Laplace transforms,Inversion of the Laplace transform,Analysis of Linear-Time-Invariant Systems using Laplace transforms.	**08**	**CO4**
V	Introduction of Z- transform, Properties of the Z-TransformationsInversion of the z-transform,One-Sided Z transformationAnalysis of Linear-Time-Invariant Systems in the Z-Domain	**06**	**CO4**
Total Hours		**44**	

Essential Readings

1. Oppenheim Alan V., Wilsky Alan S. and Nawab Hamid S., "Signals and Systems, Pearson Educations, 2nd edition, 1997
2. Prokis John G., "Digital Signal Processing: Principle, Algorithms, and Applications", Pearson Educations, 4th edition, 2007
3. Prokis John G., "Digital Signal Processing: Principle, Algorithms, and Applications, Pearson Educations, 4th edition, 2007.

Supplementary Readings

1. Lathi B. P., "Linear Systems and Signals", Oxford University Press, 2nd edition, 2009

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 204	**Electronic Circuits**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To understand the fundamental concepts of semiconductor devices		CO1	Understand the operation, current voltage characteristics and small signal models of diodes and transistors
To understand the terminal characteristics of junction diodes, bipolar transistors, and field-effect transistors.		CO2	Design and analyze electronic circuits consisting of diodes and transistors
To understand the small signal models of diodes and transistors.		CO3	Draw the input and output waveforms of various diode and transistor based electronic circuits
Design and analyze electronic circuits consisting of diodes and transistors.		CO4	Analyze the frequency response of various electronic amplifier circuits
To analyze the frequency response of various electronic amplifier circuits.			

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-
2	CO2	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-
3	CO3	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-
4	CO4	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-

SYLLABUS

No.	Content	Hours	COs
I	Review of basics of Semiconductors, Energy Levels, Extrinsic and Intrinsic semiconductors, Semiconductor Diode, Resistance Levels, Diode Equivalent Circuits, Transition and Diffusion Capacitance, Reverse Recovery Time, Load-Line Analysis	**8**	**CO1, CO2, CO3**
II	Bipolar Junction Transistors, Construction and Operation, Common-Base, Common-Emitter, Common-Collector Configuration, Transistor Amplifying Action, Limits Of Operation, DC Biasing of BJT, Operating Point, Fixed-Bias Circuit, Emitter-Stabilized Bias Circuit, Voltage-Divider Bias, DC Bias with Voltage Feedback, Thermal Stability	**10**	**CO1, CO2, CO3**
III	BJT Transistor Modeling, Small Signal Parameters Zi, Zo, Av, Ai, The re Transistor Model, Hybrid Equivalent Model, Graphical Determination of h-Parameters, BJT Small-Signal Analysis, Common-Emitter with Fixed-Bias, Voltage-Divider Bias and Emitter-Bias Configuration, Emitter-Follower Configuration, Common-Base Configuration, Effect of a Load and Source Impedance, Low and High Frequency Response of BJT Amplifier	**12**	**CO1, CO2, CO4**
IV	Field-Effect Transistors, Construction And Characteristics Of JFETS, Transfer Characteristics, Depletion and Enhancement-Type MOSFET, JFET Biasing, Fixed-Bias Configuration, Self-Bias Configuration, Voltage-Divider Biasing, JFET Small-Signal Analysis, Small-Signal Model, JFET Common Source Configuration, Source-Follower (Common-Drain) Configuration, Common-Gate Configuration, Effect of a Load and Source Impedance, Low and High Frequency Response of JFET Amplifier	**10**	**CO1, CO2, CO3**
V	Compound Configurations, Multi-stage Amplifiers, Cascade Connection, Cascode Connection, Darlington Connection, Feedback Pair, Current Mirror Circuits, Differential Amplifier Circuits	**8**	**CO2, CO3**
	Total Hours	**48**	

Essential Readings

1. R.L. Boylestad and L. Nashelsky, “Electronic Devices And Circuit Theory”, Prentice Hall, Tenth Edition, 2011.
2. D.A. Bell ,”Electronic Devices and Circuits”, Prentice Hall of India, 5th Edition, 2004

Supplementary Readings

1. A.S. Sedra and K.C. Smith, “Microelectronic Circuits”, Oxford, Seventh Edition, 2017.
2. D.A.Neaman, “Microelectronics: Circuit Analysis and Design”, McGraw Hill, Fourth Edition, 2010.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 206	**Microprocessors and Microcontrollers**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand principles and microlevel operation of processors/controllers		CO1	Ability to understand the basic concepts of processors, controllers and instruction execution.
	To develop the skills for programme the processors with low and high level programming languages		CO2	Ability to apply assembly and high level languages to program processors and controllers
			CO3	Ability to apply interfacing processor/controller with peripherals like, I/O, A/D, D/A, timer etc
			CO4	Ability to design real time applications using different microcontrollers
			CO5	
			CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
2	CO2	**3**	**2**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
3	CO3	**3**	**1**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
4	CO4	**3**	**1**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Microprocessors** 8085 Internal Architecture, Addressing Modes, Bus Timings, ASM Programming, Memory organization, overview of I/O interfacing and advanced microprocessors.	**8**	**CO1**
II	**Microcontroller: 8051 Architecture** Introduction to embedded systems, Overview of the 8051 family, Architectural Enhancements of PIC, AVR and ARM-based micro-controllers, 8051 architecture, memory organization, I/O ports, addressing modes, Assembly instructions, timing and instruction execution,	**9**	**CO1**
III	**8051 Programming** Programming examples on bit processing, Arithmetic instructions, program flow control, look up table and array processing, programming through C.	**7**	**CO1, CO2**
IV	**Concepts of Hardware Interfacing** System Design and Troubleshooting, Concepts and Programming of I/O ports, timer/counter, Serial communication (RS-232/422), Interrupt.	**9**	**CO2, CO3**
V	**Interfacing with External devices** Sensors and calibration methods, ADC/DAC, Relays, Opto-couplers, Stepper motor, DC motors, External memory, RTC, I2C, SPI, USB, VGA etc.,	**5**	**CO3, CO4**
Total Hours		**38**	

Essential Readings

1. Gaonkar R. S., “Microprocessor Architecture, Programming and Applications with 8085”, Penram International, Fifth edition 1999
2. M. A. Mazidi , J. G. Mazidi and R. D. Mckinlay others, “The 8051 Microcontroller and Embedded Systems”, Prentice Hall of India. Second Edition, 2007

Supplementary Readings

1. M.K. Patel "The 8051 Microcontrollers based Embedded Systems", MCGraw Hill, 2014
2. Hall D., “Microprocessors and Interfacing : Programming and Hardware”, Tata McGraw-Hill,1992
3. Wilmshurst, T. “Designing Embedded Systems With PIC Microcontrollers : Principles and Applications”, Elsevier (Newnes) Second Edition, 201

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 212	**Probability Theory and Stochastic Processes**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To provide the fundamentals and advanced concepts of probability theory and random process to support graduate coursework		CO1	Able to apply the specialized knowledge in probability theory and random processes to solve practical engineering problems.
	To be familiar with some of the commonly encountered random variables, in particular the Gaussian random variable		CO2	Able to distinguish interrelationship between discrete and continuous random variables and between deterministic and stochastic processes.
	To understand the classifications of random processes concepts such as strict stationarity, wide-sense stationarity and ergodicity		CO3	Able to develop mathematical models for practical design with joint distribution problems and determine theoretical solutions to the developed models.
	Analysis of random process and application to the signal processing in the communication system		CO4	Able to apply central limit theorem and random process including stationary process for definite solutions.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**3**	**-**
2	CO2	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**2**	**-**
3	CO3	**1**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**3**	**3**	**-**
4	CO4	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**2**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**The Axioms of Probability:** Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.	**06**	**CO1**
II	**The Concept of a Random Variable and its Functions:** Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions;	**07**	**CO1, CO2**
III	**Moments and Conditional Statistics:** Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds;	**08**	**CO1, CO3**
IV	**Random Sequences:** Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.	**07**	**CO3**
V	**Random Processes:** Random process, Stationary processes, mean and covariance functions, ergodicity, transmission of random process through LTI, power spectral density.	**08**	**CO2, CO4**
	Total Hours	**36**	

Essential Readings

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education, 2001.
2. *A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill, 2017.*

Supplementary Readings

1. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to ProbabilityThoery, Houghtion Mifflin; 1st Edition, 1972
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes, Waveland PrInc Publishers, 1986
3. S. M. Ross, Introduction to Probability Models, Harcourt Asia, Academic Press, 10th Edition, 2010.

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Department	**Electronics and Communication Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 224	**Computer Architecture**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To describe computer architecture concepts and mechanisms related to the design of modern processors, memories.		CO1	Ability to understand the basic structure of computer.
To apply this understanding to new computer architecture design problems within the context of balancing application requirements against technology constraints.		CO2	Ability to understand control unit operations.
To evaluate various design alternatives and make a compelling quantitative and/or qualitative argument for why one design is superior to the other approaches.		CO3	Ability to perform computer arithmetic operations.
		CO4	Ability to understand the concept of cache mapping techniques.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**3**	**3**	**3**	-	-	-	-	-	-	-	-	**2**	-	**3**	-
2	CO2	**2**	**3**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	-	**3**	-
3	CO3	**2**	**3**	**3**	**2**	**2**	-	-	-	-	-	-	-	**1**	**3**	**1**	-
4	CO4	**2**	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	-	**2**	**2**	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Fundamental Processors:** Instruction set architecture; single-cycle, FSM, and pipelined processor microarchitecture; resolving structural, data, control, and name hazards; and analyzing processor performance.	**05**	**CO1**
II	**Processor Organization:** Instruction set architecture- types, formats, addressing modes; Register set; Assembly language programming. Data path organization, Control unit design - Hardwired control, Microprogramming. CISC and RISC architecture, Instruction pipelining.	**08**	**CO2**
III	**Arithmetic and Logic unit:** Computer arithmetic- Review of addition and subtraction; Multiplication- Booth's, Array; Division- Restoring and non-restoring; Floating-point arithmetic.	**10**	**CO2, CO3**
IV	**Fundamental Memories:** Memory technology; direct-mapped vs. associative caches; write- through vs write-back caches; memory protection, translation, and virtualization; FSM and pipelined cache microarchitecture; analyzing memory performance; and integrating processors and memories.	**08**	**CO4**
V	**Advanced Memories:** Advanced cache microarchitecture; memory synchronization, consistency, and coherence.	**05**	**CO3, CO4**
	Total Hours	**36**	

Essential Readings

1. Hamacher, Vranesic, and Zaky, "Computer Organization", McGraw Hill, 5 th ed, 2002.
2. Mano M.M., "Computer System Architecture", PHI (EEE), 3 rd ed, 2016.

Supplementary Readings

1. Stallings, "Computer Organization and Architecture", PHI (EEE, 8 th ed, 2010.

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Department	Electronics and Communication Engineering	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 210	**POWER ELECTRONICS**	**3**	**0**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To describe power electronics concepts and mechanisms related to the design of modern convertors.		CO1	Ability to identify the properties of power semiconductors device
	To apply this understanding to new power electronics circuits design problems.		CO2	Ability to understand the basic concepts of power electronics such as DC/AC-DC/AC converter (rectifier, choppers, inverter & cyclo-converter)
	To evaluate various design alternatives and make a compelling quantitative and/or qualitative argument for which applications these convertors are utilized.		CO3	Ability to define and calculate efficiency of the various convertors

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-
2	CO2	**3**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-
3	CO3	**3**	**2**	**3**	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-

SYLLABUS

No.	Content	Hours	COs
I	Introduction to Power Device: Power Electronics Scope and Applications, Interdisciplinary Nature of Power Electronics, Types of power electronics circuits, Introduction to power electronic devices like Thyristor (SCR), Power BJT, Power MOSFET, GTO, IGBT, Thyristor. Characteristics, GaN HEMT, LDMOS, Super-Junction (Cool MOS), Methods of triggering and commutation.	**10**	**CO1**
II	**Phase Controlled Rectifiers / AC-DC Converter:** Principle of phase control, half wave and full wave rectifiers with R, R-L, R-L-E load, triggering scheme, Effect of source impedance on the performance or the converters.	**05**	**CO2, CO3**
III	**Choppers / DC-DC Converter:** Basic principle of chopper operation, Different methods of classification, Control strategies Duty Ratio Control and Frequency Control, Types of idealized chopper circuit, Thyristor Chopper Circuits.	**07**	**CO2, CO3**
IV	**Inverters / DC-AC Converter:** Voltage Source Inverter (VSI)- Single phase voltage source inverters, Half bridge inverters, full bridge inverters, Voltage control in single phase inverters, Pulse Width Modulated (PWM) inverters- single pulse, multiple pulse, and sinusoidal pulse modulation. Current Source Inverter (CSI), Series and parallel inverter.	**07**	**CO2, CO3**
V	**Cyclo-converter / AC-AC Converter:** Principle of AC Voltage Controllers Integral Cycle Control and Phase Control, Types of AC voltage controllers, Principle of operation of cyclo-converters, circulating and non-circulating mode of operation.	**07**	**CO2, CO3**
	Total Hours	**36**	

Essential Readings

1. M. H Rashid, “Power Electronics Circuits, Devices, and Applications”, Prentice-Hall of India Pvt. Ltd., 2004.
2. L. Umanand, “Power Electronics Essential and Applications”, Wiley India, 2009.
3. P. S. Bimbhra, “Power Electronics”, Khanna Publishers, 2003.

Supplementary Readings

1. M. D. Singh and K. B. Khanchandani, “Power Electronics”, Tata McGraw-Hill Publishing Co. Ltd., 2008.
2. M. Ned and T. M. Undeland, “Power Electronics Converters Applications and Design”, John Willey Inc., 2007.
3. V. R. Moorthi, “Power Electronics Devices, Circuits and Applications”, Oxford University Press, 2005.

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Programme	Bachelor of Technology in Electronics and Communication Engineering	Year of Regulation	**2018-19**
Department	Electronics and Communication Engineering	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINOUS EVALUATION	VIVA	Total
EC 252	**Signals and Systems Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	To develop the student's ability to analyze signals and systems	Course Outcomes	CO1	Able to analyze the signals using simulation tools
			CO2	Able to apply the signal analysis techniques to real time applications

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**	**2**	**-**
2	CO2	**2**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**2**	**-**

SYLLABUS

List of Experiments

- Generation of signals and signal operations
- Convolution and correlation on discrete time signals
- Convolution and correlation on continuous time signals
- Analysis of continuous signals in frequency domain
- Analysis of discrete signals in frequency domain
- Laplace and Z-transforms

Reference Books

1. Oppenheim Alan V., Wilsky Alan S. and Nawab Hamid S., "Signals and Systems, Pearson Educations, 2nd edition, 1997.
2. Prokis John G., "Digital Signal Processing: Principle, Algorithms, and Applications", Pearson Educations, 4th edition, 2007
3. Lathi B. P., "Linear Systems And Signals", Oxford University Press, 2nd edition, 2009.

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Department	**Electronics and Communication Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINOUS EVALUATION	VIVA	Total
EC 254	**Electronic Circuits Lab**	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives	To develop the student's ability verify the theoretical concepts and IV - characteristics of various electronic devices, studied in Electronic Devices (EC 254) through laboratory experiments.	Course Outcomes	CO1	Able to experimentally test the IV characteristics of various semiconductor devices studied in EE201, and interpret the results
			CO2	Operate electronic test equipments (CRO, Function Generator, Multimeter, power supply etc.) to characterize the behavior of semiconductor devices and circuits.
			CO3	Prepare professional quality textual and graphical presentations of laboratory data

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-
2	CO2	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-
3	CO3	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-

SYLLABUS

No.	Content	Hours	COs
I	Experiments related to measure the electrical current- voltage characteristics of various semiconductor devices including semiconductor diodes, bipolar junction transistor and field effect transistors. To study and plot the output waveforms of diode based clipper and clamper circuits. To study and plot the output waveforms and frequency response of RC low and high pass filter circuits. To study the input & output waveforms and frequency response of BJT in common emitter (CE) amplifier circuit. To study the input & output waveforms and frequency response of BJT in common base (CB) amplifier circuit. To study the input & output waveforms and frequency response of BJT in common collector (CC) amplifier circuit. To study the input & output waveforms and frequency response of FET in common source (CS) amplifier circuit. To study the input & output waveforms and frequency response of FET in common gate (CG) amplifier circuit. To study the input & output waveforms and frequency response of FET in common drain (CD) amplifier circuit. To study the input & output waveforms and frequency response of differential amplifier circuit. To study the input & output waveforms and frequency response of multistage amplifier circuit.	**16**	**CO1, CO2, CO3**
Total Hours		**16**	

Essential Readings

1. R.L. Boylestad and L. Nashelsky, "Electronic Devices And Circuit Theory", Prentice Hall, Tenth Edition, 2011.
2. D.A. Bell ,"Electronic Devices and Circuits", Prentice Hall of India, 5th Edition, 2004

Supplementary Readings

1. A.S. Sedra and K.C. Smith, "Microelectronic Circuits", Oxford, Seventh Edition, 2017.
2. D.A.Neaman, "Microelectronics: Circuit Analysis and Design", McGraw Hill, Fourth Edition, 2010.

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Department	**Electronics and Communication Engineering**	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINOUS EVALUATION	VIVA	Total
EC 256	**Microprocessors and Microcontrollers Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To understand principles and microlevel operation of processors/controllers		CO1	Ability to understand the basic concepts of processors, controllers and instruction execution.
	To develop the skills for programme the processors with low and high level programming languages		CO2	Ability to apply assembly and high level languages to program processors and controllers
			CO3	Ability to apply interfacing processor/controller with peripherals like, I/O, A/D, D/A, timer etc
			CO4	Ability to design real time applications using different microcontrollers
			CO5	
			CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
2	CO2	**3**	**2**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
3	CO3	**3**	**1**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
4	CO4	**3**	**1**	-	**2**	**3**	-	**1**	-	-	-	-	-	-	-	-
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**8085/86 Based programming (Assembly):** o Program set for Logical and Decimal. o Program set for Subroutines and Delay. o Interfacing	**04**	**CO1**
II	**8051 Based system programming (Assembly and C):** o Arithmetical and logical o I/O port interfacing. o Timer based system o Interrupt generation o Display and Keyboard interfacing, o Serial Communication o Sensor interfacing	**12**	**CO2, CO3**
III	**PIC Based system programming (Assembly and C)*:*** o I/O port interfacing. o Timer based system. o Display/Keyboard interfacing	**04**	**CO3, CO4**
	Total Hours	**20**	

Essential Readings

1. Gaonkar R. S., “Microprocessor Architecture, Programming and Applications with 8085”, Penram International, Fifth edition 1999
2. M. A. Mazidi , J. G. Mazidi and R. D. Mckinlay others, “The 8051 Microcontroller and Embedded Systems”, Prentice Hall of India. Second Edition, 2007

Supplementary Readings

1. M.K. Patel "The 8051 Microcontrollers based Embedded Systems", MCGraw Hill, 2014
2. Hall D., “Microprocessors and Interfacing : Programming and Hardware”, Tata McGraw-Hill,1992
3. Wilmshurst, T. “Designing Embedded Systems With PIC Microcontrollers : Principles and Applications”, Elsevier (Newnes) Second Edition, 201

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Department	Electronics and Communication Engineering	Semester	**IV**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 272	**Operational Amplifiers and Its Applications**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	To understand the basic fundamentals and applications of operational amplifier.	Course Outcomes	CO1	Ability to understand the basic concepts and characteristics of operational amplifiers.
			CO2	Ability to design and analyse operational amplifier based electronic circuits.
			CO3	Ability to define the prospective application of operational amplifiers is various domains.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	-	-	-
2	CO2	**3**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	-	-	-
3	CO3	**2**	**3**	-	-	-	-	-	-	-	-	-	-	**2**	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	Operational Amplifiers and Linear ICs, Introduction to the Op-Amp Parameters, Understanding Op-Amp Data Sheets, Ideal Operational Amplifiers and Op-Amp Circuits, Differential and common-Mode operation.	**10**	**CO1 & CO2**
II	Applications of Op-Amp in real time scenario, Inverting Amplifiers, Non-inverting amplifiers, Summing Amplifiers, Differential Amplifiers, Voltage –to-Current Converters, Integrators and Differentiators, Comparators and Detectors, Active Filter Circuits, Instrumentation Amplifiers	**14**	**CO2 & CO3**
Total Hours		**24**	

Essential Readings

1. D.A Bell, “Op-amps and linear ICs”, Oxford, Third Edition, 2015.
2. R. A. Gayakwad, “Op-amps and linear integrated circuits,” Prentice Hall, 2000.
3. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”,Tata McGraw Hill, 3rd Edition, 2012

Supplementary Readings

1. James M.. Fiore, “ Operational Amplifiers and Linear Integrated Circuits: Theory and Application, ” Jaico Publishing House, 1st Edition, 2002

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 301	**Analog and Digital Communication Systems**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To understand the fundamentals of modulation and demodulation of a communication system (analog and digital)	Course Outcomes	CO1	Able to acquire the knowledge about the modulation and demodulation of AM, FM, and PM
	To understand the concepts of baseband data transmission		CO2	Able to understand and design a communication system using analog modulation techniques
	To understand and analyze the signal flow digital data transmission		CO3	Able to design the communication systems for baseband data transmission and analyze the performance of binary signals in Gaussian noise
	To understand the concepts of Band pass Signal Transmission of digital data		CO4	Able to design the system for bandpass signal transmission of digital data
			CO5	Able to examine the detection performance of band pass signals in noise environment.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**3**	-	**3**	-	-	-	-	-	-	-	-	**2**	-	**2**	-
2	CO2	**3**	**2**	-	**3**	-	-	-	-	-	-	-	-	**2**	**2**	**2**	-
3	CO3	**3**	**3**	**2**	-	-	-	-	-	-	-	-	-	**2**	**3**	**2**	-
4	CO4	**2**	**1**	-	-	-	-	-	-	-	-	-	-	**3**	**2**	**2**	-
5	CO5	**2**	**1**	-	-	-	-	-	-	-	-	-	-	**3**	**2**	**2**	-

SYLLABUS

No.	Content	Hours	COs
I	**Amplitude Modulation (AM):** Introduction communication systems, Review of Fourier Transforms, need for modulation and its advantages, Circuits for generation and detection of Amplitude modulation-*Double Sideband (DSB), DSB suppressed carrier (DSB-SC), Single Sideband (SSB), Vestigial Sideband (VSB)*, Bandwidth and spectrum of AM, Superheterodyne AM receiver.	**08**	**CO1, CO2**
II	**Angle Modulation:** Concept of instantaneous frequency, Circuits for generation and detection of Angle modulation (*Narrowband (NB), Wideband (WB)*)-Frequency Modulation (FM), Phase Modulation (PM), spectra and bandwidth of Angle Modulation, Phase locked loop (PLL), FM Receivers, White Noise, Signal-to-noise ratio (SNR) analysis for analog communications.	**10**	**CO1, CO2**
III	**Baseband Transmission and Reception:** Introduction to digital communications, analog communication vs digital communication, sampling-*natural and flat-top*, Quantization of Signals, Quantization Error, Companding, waveform coding-*Pulse code modulation (PCM), Differential PCM (DPCM), Delta Modulation (DM)*, Review of Gaussian random process, detection of binary signals in gaussian noise-*maximum likelihood (ML), matched filter (MF) and correlation receivers*, *error probability performance of binary signaling*, Baseband shaping for data transmission-*Nyquist criterion, raised cosine family of pulses, intersymbol interference (ISI), equalization*.	**14**	**CO3**
IV	**Bandpass Transmission:** signal space analysis-*orthogonal expansion of signals, Gram-Schmidt procedure, representation of digitally modulated signals,* amplitude shift keying (ASK), Phase shift keying (PSK), frequency shift keying (FSK), Quadrature amplitude modulation (QAM), M-ary Digital Carrier Modulation, Mapping of Digitally Modulated Waveforms onto Constellations of Signal Points.	**08**	**CO4**
V	**Bandpass Reception:** Coherent reception, performance of matched filter receiver and correlator receive in the presence of white noise, Decision Procedure: Maximum aposteriori probability (MAP) detector, Maximum likelihood (ML) Detector, performance comparison of digital modulation schemes (Error Rate, Bandwidth), Basics of TDMA, FDMA and CDMA, any case study or Introduction to upcoming techniques of transmission.	**08**	**CO5**
	Total Hours	**48**	

Essential Readings

1. Bernard Sklar, "Digital Communications - Fundamentals and Applications," Pearson Education, 2nd Edition, 2001.
2. B.P. Lathi and Ding Zhu, “Modern Digital and Analog Communication Systems”, Oxford University Press, 4th Edition, 2010.
3. Simon. Haykin, Michael Moher, “An Introduction to Analog and Digital Communications”, John Wiley & Sons, 2nd Edition, 2007.

Supplementary Readings

1. John G. Proakis and Masoud Salehi, “Digital Communications”, McGraw-Hill, 5th Edition 2008.
2. Leon W. Couch, II, "Digital and Analog Communication Systems," Pearson Education, 6th Edition, 2004.
3. K. Sam Shanmugam, "Digital and Analog Communication Systems", Wiley India Pvt Ltd, 2006.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 303	**Electromagnetic Waves & Radiating Patterns**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To introduce principle of Electrostatic and Magnetostatic field as well as significance of Maxwell's equations		CO1	Able to acquire knowledge about Electrostatic and Magnetostatic fields
To teach the concept of electromagnetic wave in different environment and development of their conceptual idea		CO2	Able to gather knowledge about Maxwell's equations and its consequences
To teach the idea of fundamental concept of radiation		CO3	Able to understand the Electromagnetic wave and its governing concepts
To introduce the fundamental concepts of Transmission line and its application as antenna.		CO4	Able to understand the mechanism of field Radiation and its application
		CO5	Able to acquire the fundamental principle of the Transmission line and antenna with their applications
		CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**2**	**1**	-	-	-	-	-	-	-	**1**	**3**	**2**	**2**	-
2	CO2	**3**	**3**	**2**	**1**	-	-	-	-	-	-	-	**1**	**3**	**2**	**2**	-
3	CO3	**3**	**3**	**2**	**1**	-	-	-	-	-	-	-	**1**	**3**	**2**	**2**	-
4	CO4	**3**	**3**	**1**	**1**	**2**	**1**	-	-	-	-	-	**1**	**3**	**2**	**2**	-
5	CO5	**3**	**3**	**2**	**2**	**3**	**1**	-	-	-	-	-	**1**	**2**	**3**	**3**	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Electrostatic Fields** Divergence Theorem, Poisson's and Laplace's equation in various co-ordinate systems, solution of single dimensional Laplace equation, Conditions at a boundary between dielectrics, Electrostatic uniqueness theorem, capacitance, Calculation of capacitance for simple rectangular, Cylindrical and spherical geometries. Effect of multi-layer dielectrics, Energy and Mechanical forces in electric fields, Method of Electrical images for a point charge in the neighbourhood of infinite conducting plane, Application of image method for transmission line capacitance calculations.	**05**	**CO1**
II	**Magnetic Fields** Ampere's work law in differential vector form, Ampere's law for a current element. Magnetic vector Potential, Magnetic scalar Potential, Magnetic dipole, Energy and Mechanical forces in magnetic fields, Image of current carrying conductor in the neighbourhood of a magnetic plane.	**05**	**CO1**
III	**Maxwell's Equations** Introduction, The Equation of Continuity For Time-Varying Fields, Inconsistency Of Ampere's Law, Maxwell's Equation, Condition at a Boundary Surface.	**05**	**CO2**
IV	**Electromagnetic Waves** Solution For Free-Space Conditions, Uniform Plane Waves & Propagation, The Wave Equations For A Conducting Medium, Sinusoidal Time Variations, Conductors And Dielectrics, Polarization, Reflection By A Perfect Conductor Normal Incidence & Oblique Incidence, Reflection By A Perfect Dielectric — Normal Incidence & Oblique Incidence, Reflection At The Surface Of A Conductive Medium.	**12**	**CO3**
V	**Radiation** Potential Functions And Electromagnetic Field, Potential Functions For Sinusoidal Oscillations, Alternating Current Element, Power Radiated By Current Element, Application To Short Antennas, Radiation From A Monopole Or Dipole.	**9**	**CO4**
VI	**Transmission Line Analysis** Need For Transmission Line Theory, Examples Of Transmission Lines, Equivalent Circuit Representation, Theoretical Foundation, Circuit Parameters For A Parallel Plate Transmission Line, General Transmission Line Equation, Microstrip Transmission Lines, Terminated Lossless Transmission Line, Special Termination Conditions, Sourced And Loaded Transmission Line. **Antenna Fundamentals** Directional Properties Of Dipole Antennas, Two Element Array, Linear Arrays, Multiplication Of Patterns, Binomial Array, Antenna Gain, Effective Area, Transmission Loss Between Antennas, Space Communications	**12**	**CO5**
	Total Hours	**48**	

Essential Readings

1. Sadiku, "Elements of Electromagnetics", Oxford, 6th Edition, 2007
2. Hayt, William Hart, "Engineering Electromagnetic", Tata McGraw-Hill,6th Edition, 2017

Supplementary Readings

1. Reitz & Milford, "Foundations of Electromagnetic Theory", Addison-Wesley Pub., 4th Edition,2014
2. Jordan E. C. and Balmain K. G., "Electromagnetic Waves and Radiating Systems", Prentice Hall, 2nd Edition, 1964
3. K. D. Prasad, "Antenna & Wave Propagation", Satya Prakashan, 2nd edition,2009
4. Kraus John D., Marhefka Roland J. and Khan Ahmed S., "Antennas and Wave Propagation", Tata McGraw-Hill, 5th Edition,2017
5. Balanis Constantine A., "Antenna Theory, Analysis and Design", John Wiley & Sons, 4th Edition, 2016
6. Harish A. R. and Sachindananda M., "Antennas and Wave Propagation", Oxford University Press, 1st Edition, 2006

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	Bachelor of Technology in Electronics and Communication Engineering	Year of Regulation	**2018-19**
Department	Electronics and Communication Engineering	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 305	**Digital Signal Processing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To develop the student's ability to analyze discrete time signals and systems in the time domain and frequency domain.		CO1	Able to identify, formulate, and solve engineering problems in the area of signal processing.
	To develop the student's ability to perform Discrete Fourier Transform (DFT) by using different types of Fast Fourier Transform algorithms.		CO2	Able to implement FFT algorithms for computing the DFT.
	To develop student's ability to design FIR and IIR filter for various applications		CO3	Able to design and implementation of FIR and IIR filters.
	To develop the student's ability to implement digital infinite Impulse Response (IIR) and Finite Impulse Response (FIR) filters.		CO4	Able to apply down and up sampling techniques in designing of advanced digital signal processing systems.
	To understand the concepts of Multirate Signal Processing			

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**1**	**1**	-	-	-	-	-	-	-	-	**3**	-	**3**	-
2	CO2	**3**	**3**	**2**	**2**	-	-	-	-	-	-	-	-	**2**	**2**	**2**	-
3	CO3	**3**	**3**	**3**	**3**	-	-	-	-	-	-	-	**2**	**2**	-	**2**	-
4	CO4	**3**	**3**	**3**	**3**	-	-	-	-	-	-	-	**2**	**2**	**2**	**2**	-

SYLLABUS

No.	Content	Hours	Cos
I	**Review of Discrete-Time Signals and Systems** : Discrete - Time signals, systems and their classification, Analysis of Discrete - Time LTI systems: Impulse response, Difference equation, Frequency Response, Transfer Function, DTFT, DTFS and Z-transform.	**04**	**CO1**
II	**Fast Fourier Transform:** Introduction, Direct Evolution Of DFT, The Fast Fourier Transform, Decimation-In-Time Algorithm, Summary Of Steps Of Radix-2 DIT-FFT Algorithm, Decimation-In-Frequency Algorithm, Summary Of Steps Of Radix-2 DIF-FFT Algorithm.	**10**	**CO2**
III	**Finite Impulse Response Filters:** Linear Phase FIR Filters, Frequency Response of Linear Phase FIR Filters, Location of the Zeros of Linear Phase FIR Filters Fourier Series method of Designing FIR Filters, Design of FIR filters using Windows, Frequency Sampling Method of Designing FIR Filters **Infinite Impulse Response Filters:** Design of IIR Filters from Analog Filters: using Approximation of Derivatives, Impulse Invariance Technique, Bilinear Transformation and Frequency Transformation in Digital Domain	**12**	**CO3**
IV	**Realization of Digital Filters:** Realization of FIR filters; Realization of IIR Filters.	**06**	**CO3**
V	**Multirate Signal Processing:** Introduction, Down Sampling, Spectrum of The Down Sampled Signal, Up Sampling Spectrum Of The Up-Sampled Signal, Anti-Imaging Filter, Cascading Sample Rate Converters, Efficient Transversal Structure For Decimator, Efficient Transversal Structure For Interpolator.	**04**	**CO4**
	Total Hours	**36**	

Essential Readings

1. Proakis J. G. and Manolakis D. G., "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Education, 4th Edition, 2007.
2. Oppenhein A. V. and Shafer R. W., "Discrete-Time Signal Processing", Pearson Education India; 3rd edition, 2014.

Supplementary Readings

1. Mitra Sanjit K., "Digital Signal Processing: A Computer Based Approach", McGraw Hill Education; 4th edition, 2013.
2. Babu Ramesh P., "Digital Signal Processing", SciTech Publication, 2011.
3. Shaliwahan S., Vallavaraj A. and Gnanapriya C., "Digital Signal Processing", Tata McGraw-Hill, 1st Edition, 2008.
4. Padmanabhan K., "A Practical Approach to Digital Signal Processing", New Age International, 2nd Edition, 2013.

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Department	Electronics and Communication Engineering	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 311	**Embedded Systems**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To make the students to understand and program embedded systems using modern embedded ARM processors	Of Course Outcomes	CO1	Design embedded systems with appropriate hardware and software components
	To build embedded platforms, interfaces, peripherals, processors and operating systems associated with embedded systems		CO2	Analyze, program and use a typical ARM processor and its peripherals
	Design high-level drivers usage for the integration of sensors		CO3	Interface various real-time sensors using different communication protocols
	Develop a comprehensive view of the software framework being developed around embedded SOCs.		CO4	Categorize and classify operating system tasks with particular emphasis on real-time system
	Develop real time operating systems on embedded system based applications		CO5	Apply the study of embedded technology to product design

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	2	2	3	3	-	-	-	-	-	-	-	-	2	1	-	-
2	CO2	3	2	-	3	-	-	-	-	-	-	-	-	2	1	-	-
3	CO3	3	3	2	-	-	-	-	-	-	-	-	-	2	1	-	-
4	CO4	3	2	1	2	-	-	-	-	-	-	-	-	2	1	-	-
5	CO5	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	Introduction to Embedded Computing: Characteristics of Embedding Computing Applications, Concept of Real-time Systems, Challenges in Embedded System Design, Design Process. Embedded System Architecture: Instruction Set Architecture of ARM	**10**	**CO1**
II	Embedded Computing Platform: Bus Protocols, Bus Organization, Memory Devices and their Characteristics, Memory-mapped I/O, I/O Devices, I/O mapped I/O, Timers and Counters, Watchdog Timers, Interrupt Controllers, Interrupt programming, GPIO control, Sensors, Actuators, A/D and D/A Converters, Need of low power for embedded systems, Mixed Signals Processing	**14**	**CO2, CO3**
III	Programming Embedded Systems: Basic Features of an Operating System, Kernel Features, Real-time Kernels, Processes and Threads, Context Switching, Scheduling, Shared Memory Communication, Message-Based Communication, Real-time Memory Management, Dynamic Allocation, Device Drivers, Real-time Transactions and Files, Realtime OS (VxWorks, RT-Linux, Psos).	**14**	**CO3, CO4**
IV	Network Based Embedded Applications: Embedded Networking Fundamentals, Layers and Protocols, Distributed Embedded Architectures, Internet-Enabled Systems, IoT overview and architecture, Interfacing Protocols (like UART, SPI, I2C, GPIB, FIREWIRE, USB,). Various wireless protocols and its applications: NFC, Zig Bee, Bluetooth, Bluetooth Low Energy, Wi-Fi. CAN. Overview of wireless sensor networks and design examples. Case studies: Programming in Embedded C, Embedded system design using Arduino, ATOM processors, Galileo, STM, Tiva based embedded system applications.	**10**	**CO2, CO3, CO5**
	Total Hours	**48**	

Essential Readings

1. Alexander G. Dean “Embedded Systems Fundamentals with Arm Cortex M Based Microcontrollers: A Practical Approach” ARM Education media Publishers , Ist edition, 2017
2. Rob Toulson and Tim wilmshrrst “Fast and Effective Embedded Systems Design: Applying the ARM mbed “Newnes Publishers , IInd edition, 2017
3. Wayne Wolf, “Computers as Components- Principles of Embedded Computing System Design”, Morgan Kaufmann Publishers, IInd edition, 2008
4. Dogan Ibrahim”ARM-based Microcontroller Projects Using mbed”, Newnes Publishers Ist edition, 2019

Supplementary Readings

1. Lyla B. Das, “Embedded Systems –An Integrated Approach”, Pearson Publishers, Ist edition, 2013
2. Marwedel Peter, “Embedded System Design, Springer Publishers, Ist edition , 2006.
3. Barry Crowley, “Modern Embedded Computing”, Morgan Kaufmann Publishers, Ist edition, 2012

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC313	**SENSORS & TRANSDUCERS**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To understand the fundamental concepts of sensors and measurement systems		CO1	Fundamental concepts of various sensors, transducers and related electronic circuits.
To make students understand the working principle of resistive, capacitive, piezoelectric and thermal transducers and their applications.		CO2	Apply the fundamental principles of resistive, capacitive, piezoelectric and thermal transduction mechanisms for the design of various sensors and transducers.
To understand various types of electronic circuits for resistive, capacitive, piezoelectric and thermal sensors and transducers.		CO3	Design of electronic circuits for various sensors and transducers.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
2	CO2	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-
3	CO3	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Basics of Sensor and Measurement Systems** General Concepts And Terminology, Sensor Classification, General Input-Output Configuration, Static Characteristics Of Measurement Systems, Dynamic Characteristics, Review of Stress and Strain, Internal Force Analysis, Stress—Strain Relations, Bending Analysis of flexural beams and plates under simple Loading Conditions, Spring Constants, Resonant Frequency, and Quality Factor	**11**	**CO1**
II	**Piezoresistive Sensors** Origin and Expression of Piezoresistivity, Piezoresistive Sensor Materials, Metal Strain Gauges, Single Crystal Silicon, Polycrystalline Silicon, Applications of Piezoresistive Sensors:Inertial Sensors, Pressure Sensors. Tactile Sensor, Flow Sensor	**7**	**CO1, CO2**
III	**Electrostatic Sensor and Actuator** Introduction to Electrostatic Sensors and Actuators, Parallel-Plate Capacitor, Capacitance of Parallel Plates, Equilibrium Position of Electrostatic Actuator under Bias, Pull-in Effect of Parallel-Plate Actuators, Applications of Electrostatic Sensors and Actuators	**7**	**CO1, CO2**
IV	**Piezoelectric Sensor and Actuator** Introduction, Background and Mathematical Description of Piezoelectric Effects, Piezoelectric Sensing/Actuator Model, Properties of Piezoelectric Materials, Applications of Piezoelectric Sensors and Actuators	**7**	**CO1, CO2**
V	**Thermal Sensor and Actuator** Thermal Sensors, Thermal Actuators, Fundamentals of Thermal Transfer, Sensors and Actuators Based on Thermal Expansion, Thermal Bimorph Principle, Thermal Actuators with a Single Material, Thermal Couples, Thermal Resistors, Applications of Thermal Sensors and Actuators	**7**	**CO1, CO2**
VI	**Electronic Circuits for Sensors and Transducers** DC and AC Bridges: Kelvin bridge and Wheatstone bridge for resistance measurement, Schering bridge and Wien bridge for capacitance measurement, Maxwell bridge and Hay's bridge for inductance measurement, Operational Amplifiers and Signal Conditioning for Sensors and Transducers	**9**	**CO3**
	Total Hours	**48**	

Essential Readings

1. Ghosh A. K., “Introduction to Transducers”, Prentice-Hall India, 1st Ed., 2015.
2. Chang Liu, “Foundations of MEMS”, Pearson, 2nd Edition, 2012.
3. H S Kalsi, “Electronic Instrumentation and Measurement”, Mc Graw Hill, 4th Ed, 2019.

Supplementary Readings

1. Patranabis D., "Sensors And Transducers", Prentice-Hall India, 2nd Ed., 2004.
2. Webster J.G., "Instrumentation and Sensors Handbook", CRC Press, 1st Ed., 1999.

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Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 315	**Biomedical Instrumentation**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
			CO1	Ability to understand heart system and measurement
	To understand the various electronics instrument and their measurement methods		CO2	Ability to understand the Cardiovascular Measurements and Devices
	To understand the Electrical Activity in Neuromuscular System and Brain		CO3	Ability to understand the Electrical Activity in Neuromuscular System and Brain
	To understand the Cardiovascular Measurements and Devices		CO4	Ability to understand the advances on various medical equipment

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**3**	-	-	-	-	-	-	-	-	-	**3**	**3**	**3**
2	CO2	**3**	**2**	**3**	-	-	-	-	-	-	-	-	-	**2**	**2**	**2**
3	CO3	**3**	**2**	**3**	-	-	-	-	-	-	-	-	-	**3**	**3**	**3**
4	CO4	**3**	**2**	**3**	-	-	-	-	-	-	-	-	-	**2**	**2**	**2**
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	Physiological Systems of The Body: Brief description of neuronal, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities. Electrodes, Sensors and Transducers: Bioelectric signals, Electrodes for biophysical sensing; surface electrodes; microelectrodes; review of transducers and other sensors for bio-medical applications. The Heart System and Measurements: The heart; electro conduction system of the heart; the heart as a potential source; the ECG waveform; the standard lead system; the ECG preamplifier; ECG machines.	**12**	**CO1**
II	Cardiovascular Measurements and Devices: Physiological pressures; blood pressure measurements; sphygmo manometers; oscillometric and ultrasonic methods; direct methods: manometers; pressure transducers; pressure amplifiers; typical calibration methods; systolic, diastolic and mean pressure detector circuits; pressure differentiation (dp/dt) circuits; automatic zero circuits; practical problems in pressure monitoring; cardiac output measurement; plethysmography; blood flow measurements; phonocardiography; vector cardiography; defibrillators circuits; pacemakers; heart lung machines.	**12**	**CO2**
III	The Human Respiratory System and Its Measurement: Internal (cellular) and external (lung) respiration; organs of respiration; mechanics of breathing; parameters of respiration; regulation of respiration; unbalanced and diseased states; environmental threats to the respiratory system; respiratory system measurements; respiratory transducers and instruments; spirometers; Respirator	**12**	**CO2**
IV	Measurement of Electrical Activity in Neuromuscular System and Brain: Neuron potential; muscle potential; electromyography (EMG); electroencephalography (EEG); EEG electrodes and the 10-20 system; EEG amplitude and frequency bands; the EEG system – simplified block diagram; preamplifiers and EEG system specifications; EEG diagnostic uses and sleep patterns; visual and auditory evoked potential recordings; EEG system artifacts.	**8**	**CO3**
V	Advances In Bio-Medical Instrumentation: Computer Tomography; Magnetic Resonance imaging; X-ray; Nuclear medicine; Ultrasound; lasers; Electromagnetic interference; Electrical safety; Bedside monitor.	**4**	**CO4**
	Total Hours	**48**	

Essential Readings

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th edition., Singapore: Pearson Education, Inc., (2001). (ISBN 81-7808- 327-2)
2. Cromwell L., Weibell F. J. and Pfeiffer E. A., "Biomedical Instrumentation and Measurements", 2nd edition. Singapore: Pearson Education Inc., (2003). (ISBN 812970028X)

Supplementary Readings

1. J. G. Webster , "Encyclopedia of Medical Devices and Instrumentation", 2nd Edition, New York: Wiley, 2006.
2. J. D. Bronzino, "The Biomedical Engineering Handbook", CRC Press, 3rd Edition, 2006.
3. R S. Khandpur, "Handbook on Biomedical Instrumentation", Tata McGraw-Hill Education, 2003 edition.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-2019**
Department	Electronics and Communication Engineering	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 321	**Linear Integrated Circuits**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Of Course Outcomes		
	To make the students to understand Signal analysis using Op-amp based circuits.		CO1	Ability to analyze the characteristics of Op-Amp
	To understand functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits		CO2	Abiity to realize the importance of Signal analysis using Op-amp based circuits
	To Develop applications of Op-amp integrated circuits		CO3	Functional blocks and the applications of special ICs like Timers, PLL circuits, regulator Circuits.
	To report the Operation of IC voltage regulators, SMPS & Function generators		CO4	Abilty to build Applications with the help of Op-amp integrated circuits
			CO5	Ability to understand and analyse, linear integrated circuits their and Application.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	-	**1**	**3**	-	-	-	-	-	-	-	-	-	**3**	**2**	**2**	-
2	CO2	**2**	**2**	**3**	**3**	-	-	-	-	-	-	-	-	**2**	**2**	**2**	-
3	CO3	**2**	-	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**2**	-
4	CO4	**2**	-	**1**	**2**	-	-	-	-	-	-	-	-	**3**	**3**	**3**	-
5	CO5	-	**1**	**3**	**3**	-	-	-	-	-	-	-	-	**3**	**2**	**2**	-

SYLLABUS

No.	Content	Hours	COs
I	Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Basic applications of op -amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-V/I & I/V converters.	**10**	**CO1**
II	Instrumentation amplifier and its applications for transducer Bridge, Log and Antilog Amplifiers- Analog multiplier & Divider, first and second-order active filters, comparators, multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types), A/D converters using opamps, positive and negative FeedBack amplifiers, opamp-small signal analysis,	**12**	**CO2, CO3**
III	Functional block, characteristics of 555 Timer and its PWM application - IC-566 voltage controlled oscillator IC; 565-phase locked loop IC, Schmitt trigger, AD633 Analog multiplier ICs.	**6**	**CO3, CO4**
IV	AD623 Instrumentation Amplifier and its application as load cell weight measurement - IC voltage regulators –LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply - LM317, 723 Variability voltage regulators, switching regulator- SMPS - ICL 8038 function generator IC.	**08**	**CO2, CO3, CO5**
	Total Hours	**36**	

Essential Readings

1. David A. Bell, “Op-amp & Linear ICs”, Oxford, 2nd edition, 2013.
2. D. Roy Choudhary, Sheil B. Jani, “Linear Integrated Circuits”, New Age Publisher, 2nd edition, 2003.
3. Ramakant A.Gayakward, ‘Op-amps and Linear Integrated Circuits’, Pearson Education, 4th edition, 2015

Supplementary Readings

1. Fiore,”Opamps & Linear Integrated Circuits Concepts & applications”, Cengage Learning, Ist edition, 2010.
2. Floyd ,Buchla,”Fundamentals of Analog Circuits”, Pearson Education , 2nd edition, 2001
3. Jacob Millman, Christos C.Halkias, “Integrated Electronics - Analog and Digital circuits system”, McGraw Hill, 2nd edition , 2017.
4. Robert F.Coughlin, Fredrick F. Driscoll, ‘Op-amp and Linear ICs’, Pearson Education, 6th edition, 2000.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 323	**Image Processing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To study fundamentals of digital image processing.		CO1	Ability to understand the fundamentals of digital image processing.
	To study the various image enhancement techniques in spatial and frequency domain		CO2	Ability to analyse the different enhancement techniques of images in spatial and frequency domain.
	To study different causes for image degradation and image restoration techniques.		CO3	Ability to understand the different causes for image degradation and image restoration techniques.
	To study the morphological operations used in image processing.		CO4	Ability to analyze the various morphological operations used in image processing.
	To study the image segmentation techniques		CO5	Ability to analyse the various techniques employed for images segmentation.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**1**	**1**	**-**
2	CO2	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**2**	**-**
3	CO3	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**1**	**2**	**-**
4	CO4	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**2**	**-**
5	CO5	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**2**	**-**

SYLLABUS

No.	Content	Hours	COs
I	Digital Image Fundamentals Digital Image, Image Processing Origins; Fundamentals of Image Processing; Components of Image Processing Systems. Visual Perception, Human Eye, Brightness Adaptation and Discrimination, Image Sensing and Acquisition, Image Formation Models; Image Sampling and Quantization Basic Concepts, Representation Of Image, Special and Gray Level Resolution, Aliasing, Zooming and Shrinking; Relationships Between Pixels, Nearest Neighbour, Adjacency, Connectivity, Regions, And Boundaries; Distance Measures; Image Operations On A Pixel Basis; Linear And Nonlinear Operations.	**7**	**CO1**
II	Image Enhancement in Spatial Domain and Frequency Domain Gray Level Transformations - Image Negatives, Log, Power-Law and Piecewise Linear Transformation Functions; Histogram Processing, Equalization, Matching; Enhancement Operations - Arithmetic, Logic, Subtraction and Averaging; Spatial Filtering, Linear and Order-Statistics For Smoothing, First and Second Derivatives/Gradients for Sharpening, 2-D Fourier Transform, its Inverse and Properties; Discrete and Fast Fourier Transform; Convolution and Correlation Theorems; Filtering in Frequency Domain - Low Pass Smoothing, High Pass Sharpening, Homomorphic Filtering.	**10**	**CO2**
III	Image Restoration Image Degradation and Restoration Processes; Noise 'Models - Spatial Properties, Noise Probability Density Functions, Periodic Noise, Estimation of Noise Parameters; Restoration in the Presence Of Noise and Mean Filters, Order-Statistics Filters, Adaptive Filters; Linear Position-Invariant Degradations and Estimation.	**6**	**CO3**
IV	Morphological Image Processing Preliminaries-Set Theory And Logic Operations In Binary Images; Basic Morphological Operations - Opening, Closing Operators, Dilation and Erosion; Morphological Algorithms - Boundary Extraction, Region Filling, Extraction Of Connected Components, Convex Hull, Thinning, Thickening, Skeletons.	**6**	**CO4**
V	Image Segmentation Detection of Discontinuities Point, Line And Edges; Edge Linking and Boundary Detection - Local Processing, Global Processing Using Hough Transform; Thresholding - Local, Global And Adaptive; Region-Based Segmentation - Region Growing, Region Splitting And Merging.	**7**	**CO5**
	Total Hours	**36**	

Essential Readings

1. Gonzalez R. C. and Woods R. E, "Digital Image Processing", Pearson Prentice Hall, 2nd edition, 2002.

Supplementary Readings

1. Sonka M. Hlavac V., Boyle R., "Image Processing, Analysis and Machine Vision", Cengage Learning, 3rd edition, 2007.
2. Gonzalez R. C, Woods R. E and Eddins S. L "Digital Image Processing using MATLAB", McGraw Hill Education, 2nd edition, 2017.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 325	**Statistical Communication Theory**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To provide students an understanding of the concepts related to statistical theory for communication.		CO1	Able to understand how the information is measured and able to use it for effective coding.
	To explore the measures of information and uncertainty such as entropy and mutual information knowledge in various applications.		CO2	Able to gain insights into how the channel capacity is computed for various channel models.
	To familiarize students on channel capacity and its bound on various channels.		CO3	Able to use the statistical information in basic detection theory to solve the problems related to communication engineering.
	To summarize the application of detection and estimation theory in communication (wired and wireless).		CO4	Enabling the students to think in terms of innovative ideas to improve the existing technology in the field of communication through improving the estimation process.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**3**	**-**
2	CO2	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**1**	**2**	**-**
3	CO3	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**-**
4	CO4	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**	**2**	**3**	**2**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Information and Entropy:** Information measure, Entropy of a source, Properties of Entropy, Joint and conditional entropies, Mutual information, Relationship between Entropy and Mutual Information, Chain Rules for Entropy, Kraft Inequality, Optimal Codes, bounds on the Optimal Code Length, Huffman Codes, Optimality of Huffman Codes.	**08**	**CO1**
II	**Channel Capacity** Discrete memoryless channels and their channel capacities, Properties of Channel Capacity, Introduction to Shannon capacity theorem, Preview of the Channel Coding Theorem, Channel Coding Theorem, Zero-Error Codes, Fano's Inequality and the Converse to the Coding Theorem, hamming codes.	**08**	**CO2**
III	**Statistical Decision Theory:** Introduction, Binary hypothesis testing, Baye's Criterion, minimax and Neyman-Pearson tests, Composite Hypothesis testing.	**06**	**CO3**
IV	**Parameter estimation I:** Review of Gaussian Variables and Processes, Minimum Variance Unbiased Estimation (MVUE), Fisher Information Matrix, Cramer-Rao Lower Bound, Linear Models, Generalized Minimum Variance Unbiased Estimation, Best Linear Unbiased Estimators (BLUE)	**07**	**CO4**
V	**Parameter estimation II:** Maximum Likelihood (ML) estimation, Generalized Likelihood ration test, Bayes Estimation- Minimum Mean-Square Error Estimate (MMSE), Maximum A Posteriori Estimate (MAP), Least Square Estimation (LS), Any case study.	**07**	**CO4**
	Total Hours	**36**	

Essential Readings

1. Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", Second Edition, Wiley Series in Telecommunications and Signal Processing. Wiley-Interscience, USA, 2006.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", First edition, Printice hall, Volume II, 1998.
3. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", First edition, Printice hall, Volume I, 1993.

Supplementary Readings

1. R. B. Ash, "Information Theory", First edition, Dover Publisher, 1990.
2. Mourad Barkat, "Signal Detection and Estimation", Second Edition, Artech House, 2005.
3. H.V.Poor, "An Introduction to Signal Detection and Estimation", Second Edition, Spring Verlag.1994.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINOUS EVALUATION	VIVA	Total
EC 351	**Analog and Digital Communication Systems Laboratory**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To develop the student's ability to analyse and design Analog Communication systems		CO1	Able to develop Analog Communication Systems using simulation tools/hardware kit
	To develop the student's ability to analyse and design Digital Communication systems		CO2	Able to develop Digital Communication Systems using simulation tools/hardware kit
	To understand and analyze the signal flow digital data transmission in the presence of AWGN channel		CO3	Able to work in teams to plan and execute the creation of Advanced Digital Communication systems

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**
2	CO2	**2**	**3**	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**
3	CO3	**3**	**2**	**1**	**1**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**2**	**1**

SYLLABUS

No.	Content	Hours	COs
1.	List of experiments related to Analog and Digital communication systems: ➢ Generation and demodulation of conventional AM signal. ➢ Generation and demodulation of DSB-SC AM signal. ➢ Generation and demodulation of SSB signal. ➢ Generation and demodulation of FM signal. ➢ To calculate the SNR for the AM, DSB-SC, SSB-SC signal with AWGN channel. ➢ To observe the pre-emphasis and de-emphasis of a signal. ➢ Signal generation and reconstruction based on sampling theorem and Nyquist criteria ➢ To generate and demodulate amplitude shift keyed (ASK) signal ➢ To generate and demodulate binary phase shift keyed (BPSK) signal and Quadrature Phase shift keying technique (QPSK) signal ➢ To generate and demodulate frequency shift keyed (FSK) signal ➢ To generate and demodulate Quadrature amplitude modulation (QAM) signal ➢ Transmission of signals using digital modulation techniques: M-ary FSK, M-ary QAM and Error performance of M-ary signalling schemes in AWGN channels ➢ Assume BPSK modulation is used for SNR range of 0-15 dB with a step of 2 dB. Length=1000 bits. Simulate: i) BER of system ii) Plot BER vs SNR performance for simulated results ➢ BER comparison of various digital modulation schemes under Rayleigh channel	**18**	**CO1, CO2, CO3**
	Total Hours	**18**	

Essential Readings

1. Bernard Sklar, "Digital Communications - Fundamentals and Applications," Pearson Education, 2nd Edition, 2001.
2. B.P. Lathi and Ding Zhu, "Modern Digital and Analog Communication Systems", Oxford University Press, 4th Edition, 2010.
3. Simon. Haykin, Michael Moher, "An Introduction to Analog and Digital Communications", John Wiley & Sons, 2nd Edition, 2007.
4. John G. Proakis and Masoud Salehi, "Contemporary Communication Systems using Matlab", Cengage learning, 3rd edition, 2011.

Supplementary Readings

1. John G. Proakis and Masoud Salehi, "Digital Communications", McGraw-Hill, 5th Edition 2008.
2. Leon W. Couch, II, "Digital and Analog Communication Systems," Pearson Education, 6th Edition, 2004.
3. K. Sam Shanmugam, "Digital and Analog Communication Systems", Wiley India Pvt Ltd, 2006.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation: **2018-19**
Department	**Electronics and Communication Engineering**	Semester: **V**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINUOS EVALUATION	VIVA	Total
EE 353	**Electromagnetic Waves & Radiating Patterns Laboratory**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	Course Outcomes	
To develop the student's ability to analyse the radiation related issues and introduction to the simulator.	CO1	Implement a radio frequency antenna using simulation tools
To develop the ability to design and study on the antenna characteristics.	CO2	Will develop understanding on practical scenario RF antenna design issues.
To develop the ability and concepts of the RF antenna designing parameters.	CO3	Work in teams to plan and execute the design of RF antenna
	CO4	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
1	CO1	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**3**	**1**	**2**	**2**	**3**	**3**	**2**	**-**
2	CO2	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**3**	**1**	**2**	**2**	**3**	**3**	**2**	**-**
3	CO3	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**3**	**1**	**2**	**2**	**3**	**3**	**2**	**-**
4	CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	To Study Radiation Pattern of Dipole Antenna in Two Planes	**14**	**CO1, CO2, CO3**
II	To Study Effects of Parasitic Elements in Yagi-Uda Antenna		
III	To Study Current Distribution on Dipole Antenna		
IV	To Study Radiation Pattern of Microstrip Antennas		
V	To Design & Test Helical Antennas		
VI	To Design & Test Loop Antennas		
VII	To Study Gain of Different Antennas		
	Total Hours	**14**	

Essential Readings

1. Sadiku, "Elements of Electromagnetics", Oxford, 6th Edition, 2007
2. Hayt, William Hart, "Engineering Electromagnetic", Tata McGraw-Hill,6th Edition, 2017

Supplementary Readings

1. Reitz & Milford, "Foundations of Electromagnetic Theory", Addison-Wesley Pub., 4th Edition,2014
2. Jordan E. C. and Balmain K. G., "Electromagnetic Waves and Radiating Systems", Prentice Hall, 2nd Edition, 1964
3. K. D. Prasad, "Antenna & Wave Propagation", Satya Prakashan, 2nd edition,2009
4. Kraus John D., Marhefka Roland J. and Khan Ahmed S., "Antennas and Wave Propagation", Tata McGraw-Hill, 5th Edition,2017
5. Balanis Constantine A., "Antenna Theory, Analysis and Design", John Wiley & Sons, 4th Edition, 2016
6. Harish A. R. and Sachindananda M., "Antennas and Wave Propagation", Oxford University Press, 1st Edition, 2006

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	Bachelor of Technology in Electronics and Communication Engineering	Year of Regulation	**2018-19**
Department	Electronics and Communication Engineering	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINOUS EVALUATION	VIVA/QUIZ	Total
EC 355	**Digital Signal Processing Laboratory**	**0**	**0**	**2**	**1**	**70**	**30**	**100**

Course Objectives		Course Outcomes		
	To develop the student's ability to analyze Digital Signal Processing (DSP) systems		CO1	Able to develop a DSP system using simulation tools
	To develop the student's ability to design DSP systems for various applications		CO2	Apply DSP systems to real world applications
	To develop the student's ability in simulating of the DSP systems before its implementation.		CO3	Work in teams to plan and execute the creation of complex DSP systems.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**
2	CO2	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**2**	**-**
3	CO3	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**2**	**2**

SYLLABUS

No.	Content	Hours	COs
1	Generation of discrete-time signals in the time domain and performing basic operations	**14**	**CO1, CO2, CO3**
2	Simulation of some simple discrete-time systems on the computer using simulation tool and investigate their time domain properties		
3	Analysis of discrete-time signals using DFT		
4	FIR and IIR filters		
5	Multirate signal processing		
6	Implementation of linear and circular convolution on DSP processor TMS320C6748		
7	Implementation of FIR filters on DSP processor TMS320C6748		
	Total Hours	**14**	

Essential Readings

1. Proakis J. G. and Manolakis D. G., "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Education, 4th Edition,2007.
2. *Oppenhein A. V. and Shafer R. W., "Discrete-Time Signal Processing", Pearson Education India; 3rd edition, 2014.*

Supplementary Readings

1. Padmanabhan K., "A Practical Approach to Digital Signal Processing", New Age International, 2nd Edition, 2013.
2. Mitra Sanjit K., "Digital Signal Processing: A Computer Based Approach", McGraw Hill Education; 4th edition, 2013.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**V**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 371	**MICROSENSOR TECHNOLOGY**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	To understand the fundamental concepts, working principles and applications of Microsensors	Course Outcomes	CO1	Understand the fundamental concepts and applications of Microsensors
	To design various types of Microsensors based on resistive, capacitive, piezoelectric and thermal transduction mechanisms.		CO2	Apply the concept of various transduction mechanisms for the design of Microsensors
	To make students understand the fabrication technologies and materials for Microsensors		CO3	Understand the materials and fabrication technologies for Microsensors.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	**1**	-	-
2	CO2	**2**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	**1**	-	-
3	CO3	**2**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	**1**	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Basics of Sensor and Measurement Systems** General Concepts And Terminology, Sensor Classification, General Input-Output Configuration, Characteristics of Measurement Systems, Basic mechanical structures for Microsensors	**6**	**CO1**
II	**Transduction mechanisms in Microsensors** Piezoresistive, Capacitive, Piezoelectric and Thermal transduction techniques for Microsensors	**6**	**CO2**
III	**Technologies and materials for Microsensors** Materials used for making Microsensors and their fabrication techniques	**6**	**CO3**
IV	**Case studies of selected Microsensors** Piezorsisive pressure sensor, Capacitive pressure sensor, Piezoelectric sensor and Temperature sensor	**6**	**CO1, CO2, CO3**
	Total Hours	**24**	

Essential Readings

1. Gardner J.W., Varadan V.K., Awadelkarim O.O., “Microsensors, MEMS and Smart Devices”, John Wiley & Sons Ltd, 1st Ed., 2001.
2. Chang Liu, “Foundations of MEMS”, Pearson, 2nd Edition, 2012.

Supplementary Readings

1. Ghosh A. K., “Introduction to Transducers”, Prentice-Hall India, 1st Ed., 2015.
2. Patranabis D., "Sensors And Transducers", Prentice-Hall India, 2nd Ed., 2004.
3. Frank R., “Understanding Smart Sensors”, Artech House, 2nd Ed., 2000.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 302	**Digital and Analog Integrated Circuits**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand the MOSFET structure and Operation		CO1	Model the behaviour of a MOS Transistor
	To understand the CMOS differential Amplifier		CO2	Design of MOS differential amplifier
	To develop an ability of CMOS operational amplifier		CO3	Able to compute the MOS operational amplifier
	To develop the CMOS digital circuits		CO4	Able to analyse CMOS Inverter
			CO5	Able to analyse and design of CMOS digital circuits

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	-	**1**	**1**	-	-	-	-	-	-	-	-	**3**	-	**3**
2	CO2	-	**3**	**2**	**1**	-	-	-	-	-	-	-	-	**2**	-	**2**
3	CO3	-	-	**3**	-	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**
4	CO4	-	**2**	**3**	-	-	-	-	-	-	-	-	**1**	**2**	**3**	**2**
5	CO5	-	-	**3**	**2**	-	-	-	-	-	-	-	**1**	**3**	**3**	**3**
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**MOS Transistor** MOS Structure and Operation, MOSFET Structure And Operations, MOSFET Current- Voltage Characteristics, Channel Length Modulation, Substrate Bias Effect, MOSFET Capacitances, MOSFET Model**.**	**10**	**CO1**
II	**CMOS Differential Amplifiers** BJT/MOSFET Differential Amplifier, DC Transfer Characteristics of An Emitter-Coupled Pair / Source - Coupled Pair, Current Mirrors (Bipolar / MOS), Bipolar Widlar Current Source/ MOS Widlar Current Source, Cascaded Differential Amplifier Stages and Level Translator, AC and DC Analysis of Cascade Amplifier**.**	**08**	**CO2**
III	**CMOS Operational Amplifier Fundamentals** Operational Amplifier, Basic Op-Amp Configuration, An Op-Amp with Negative Feedback, Voltage Series and Voltage Shunt Configurations, Difference Amplifiers, Specification of An Op-Amp, Offset Voltages and Currents, CMRR, Slew Rate, PSRR, Frequency Response, GBW Product, Input Bias and Offset Currents.	**06**	**CO2, CO3**
IV	**NMOS Logic Design** Resistive-Load Inverter, Saturated-Loaded Inverter, Linear Loaded Inverter, Depletion Loaded Inverter, Graphical Determination of VTC, Calculation of VTC Critical Points, Power Dissipation and Rise Time - Fall Time, NMOS Logic Gates.	**06**	**CO2, CO3**
V	**CMOS Logic Design** CMOS Inverter Technology, Static Characteristics, Dynamic Behavior, Static and Dynamic Power Dissipation, Power-Delay Product. CMOS Gates, TTL-CMOS Interfacing.	**08**	**CO3, CO4, CO5**
VI	**Processing Technology** Fabrication Process Flow, CMOS N-Well Process, Layout Design Rules, Full-Custom Mask Layout Design, Stick Diagram**.**	**04**	**CO2, CO4**
VII	**Semiconductor Memories** Type of Memories, Implementation Of ROMs, MOS ROM Cells, MOS EPROM and EEPROM Applications, Static and Dynamic Read Write Memories, Organization of RAM, Paralleling of Semiconductor Memory Integrated Circuit Chips.	**06**	**CO4**
	Total Hours	**48**	

Essential Readings

1. S-M. Kang and Y. Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", Tata McGraw-Hill, 3rd Edition, 2002
2. B. Razavi, “Design of Analog CMOS Integrated Circuit” Tata McGraw-Hill, 2rd Edition, 2017

Supplementary Readings

1. H. Taub and D. Schilling, "Digital Integrated Electronics", McGraw-Hill, International, 2017.
2. R. Jan, A. Chandrakasan, and B. Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition 1999.
3. S. Salivahanan S., "Linear Integrated Circuits", McGraw-Hill, 3rd Edition, 2018

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation: **2018-19**
Department	**Electronics and Communication Engineering**	Semester: **VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 304	**RF & Microwave Engineering**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To introduce principle of the RF behaviours of Passive Components as well the idea of Single- and multiport networks, Smith chart.	CO1	Able to acquire knowledge about RF behaviours of Passive Components, Single- and multiport networks and Smith chart.
To introduce the fundamental concepts of Microwave waveguides, and RF filters.	CO2	Able to understand the working mechanism of Microwave waveguides and RF filters.
To develop the idea of fundamental concept of microwave devices and sources.	CO3	Able to understand the concepts of microwave devices and sources.
To develop the fundamental concept of microwave antenna and antenna parameters.	CO4	Able to gather the fundamental knowledge about microwave antenna and antenna parameters.
To introduce some ideas about RADAR and Microwave communications along with navigation system.	CO5	Able to acquire the fundamental principle of the Microwave communications and electronic navigation system.
	CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**2**	**1**	**3**	-	-	-	-	-	-	**1**	**3**	**2**	**2**	-
2	CO2	**3**	**3**	**2**	**1**	**3**	-	-	-	-	-	-	**1**	**3**	**2**	**2**	-
3	CO3	**3**	**3**	**2**	**1**	-	-	-	-	-	-	-	**1**	**3**	**2**	**2**	-
4	CO4	**3**	**3**	**1**	**1**	**3**	**1**	-	-	-	-	-	**1**	**3**	**2**	**2**	-
5	CO5	**3**	**3**	**2**	**2**	-	**1**	-	-	-	-	-	**1**	**2**	**3**	**3**	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** RF behaviours of Passive Components, Chip Components.	**03**	**CO1**
II	**Single- and multiport networks and Smith chart** Basic Definitions, Interconnecting Networks, Network Properties and Application, Scattering Parameters- Definition and Meaning Of S- Parameters, From Reflection Coefficients to Load Impedance, Impedance Transformation, Admittance Transformation, Parallel and Series Connection.	**08**	**CO1**
III	**Microwave waveguides, components and RF Filter** Introduction, Rectangular Waveguides, Rectangular Cavity Resonators, Microwave Hybrid Circuits: Waveguides Tees, Magic Tees, Directional Couplers, Basic Resonator and Filter Configurations, Special Filter Realizations.	**8**	**CO2**
IV	**Microwave devices and sources** Microwave Bipolar Transistors, Microwave Tunnel Diodes, Gunn Diodes, Klystrons and Magnetrons**.**	**10**	**CO3**
V	**Microwave Antennas** Antenna Characteristics: Radiation Pattern, Beam Width; Radiation Resistance and efficiency; Directivity and Gain, Impedance, VSWR, Polarization; Effective height and Receive Aperture; Noise Temperature of Antenna. Radiation fields and Characteristics of λ/2 dipole; discussion on λ/4 monopole antenna; Current distribution and Radiation patterns of centre-fed dipoles of length λ, 3λ/2 and 2 λ. Horizontal and Vertical antennas over a plane ground. Antenna Arrays: electric Field due to 2 element arrays, 3 element Arrays; Pattern Multiplication; Uniform Linear Array: End fire and Broad side; Phased array.	**12**	**CO4**
VI	**RADAR and Microwave communications** Basic Radar, Simple Form of Radar Equation, Radar Block Diagram, Detection of Signal Noise, Receiver Noise & SNR, Transmitted Power, PRF, Antenna Parameters, Introduction to Doppler And MTI Radar, Simplified Microwave System, Microwave Repeaters, Diversity, Microwave Radio Stations, System Gain. **Electronic navigation** Instrument Landing System, Precision Approach Radar, Microwave Landing System, Satellite Navigation Systems (GPS).	**07**	**CO5**
	Total Hours	**48**	

Essential Readings

1. L. Samuel Y., "Microwave Devices and Circuits", PHI, 3rd Edition,2014
2. F. Gustrao, "RF & Microwave Engineering", Wiley, 2nd edition, 2012

Supplementary Readings

1. D. Annapurna and D. Sisir K., "Microwave Engineering", Tata McGraw-Hill, 3rd Edition, 2017
2. S. Merril I., "Introduction to Radar Systems", Tata McGraw-Hill, 3rd edition, 2014
3. R.S. Rao, "Microwave Engineering", PHI, 2nd Edition, 2012
4. D. M. Pozar, "Microwave Engineering", Wiley, 4th Edition, 2011
5. C. A. Balanis, "Antenna Theory: Analysis and Design", Wiley, 4th Edition, 2011

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018 – 19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 310	**Artificial Neural Networks and Applications**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	To introduce the neural networks for classification and regression	Course Outcomes	CO1	Able to understand the differences between networks for supervised and unsupervised learning
	To give design methodologies for artificial neural networks		CO2	Able to design single and multi-layer feed-forward neural networks
	To demonstrate neural network applications on real-world tasks		CO3	Able to design radial basis function networks and support vector machines for signal processing applications.
			CO4	Able to apply PCA in the reduction of the feature vector dimension and also develop self organizing maps for real world applications.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**
2	CO2	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**2**	**-**
3	CO3	**-**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**-**
4	CO4	**-**	**2**	**-**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**-**

SYLLABUS

No.	Content	Hours	Cos
I	Introduction: Neural networks characteristics, History of development in neural networks principles, Artificial neural net terminology, Model of a neuron, Topology, Learning, Types of learning, Supervised, Unsupervised, Reinforcement learning, knowledge representation and acquisition Learning Process: Competitive, Boltzmann learning, Credit Assignment Problem, Memory, Adaption, Statistical nature of the learning process.	**10**	**CO1**
II	Single Layer Perceptrons: Adaptive filtering problem, Unconstrained Organization Techniques, Linear least square filters, least mean square algorithm, learning curves, Learning rate annealing techniques, perception –convergence theorem, Relation between perception and Bayes classifier for a Gaussian Environment. Multilayer Perceptrons: Back propagation algorithm XOR problem, Heuristics, Output representation and decision rule, Computer experiment, feature detection, Back propagation and differentiation, Hessian matrix, Generalization, Cross validation, Network pruning Techniques, Virtues and limitations of back propagation learning, accelerated convergence, supervised learning.	**12**	**CO2**
III	Radial-Basis Function Networks: Cover's theorem on the separability of patterns, separability and interpolation, Posed surface reconstruction, Solution of regularization equation: Greens function, Use of Greens function in regularization networks, Regularization networks and generalized RBF. Support Vector Machines: Optimal hyperplane for linearly separable patterns, Optimal hyperplane for nonseparable patterns, How to build a support vector machine for pattern recognition, Support vector machines for nonlinear regression.	**12**	**CO3**
IV	Principal Components Analysis: Some intuitive principles of self organization, Principal components analysis, Hebbian-based principal components analysis, Dimensionality reduction using PCA. Self-Organizing Maps: Basic feature mapping models, Self-organizing map, Learning vector quantization, Hierarchical vector quantization.	**10**	**CO4**
	Total Hours	**44**	

Essential Readings

1. S. Haykin, "Neural networks and Learning Machines", Pearson Education, 3rd Edition, 2013.

Supplementary Readings

1. B.Vegnanarayana, "Artificial neural networks", Prentice Halll of India, 1998.
2. Li Min Fu, "Neural networks in Computer intelligence", McGraw Hill Education, 1st Edition, 2003.
3. James A. Freeman and David M. Skapura, "Neural Networks: Algorithms, Applications, and Programming Techniques", Addison-Wesley, 1991.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 313	**Fundamentals of Microwave Antenna and Propagation**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand the fundamentals of antenna and its parameters		CO1	Able to acquire the knowledge about fundamentals of antenna and its parameters
	To understand the concepts of antenna array		CO2	Able to understand the basic concepts of antenna array
	To understand analyse different types of antenna		CO3	Able to understand and analyse different types of antenna
	To understand various of propagation characteristics		CO4	Able to understand various propagation characteristics

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**3**	**2**	**2**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
2	CO2	**3**	**2**	**3**	**2**	**2**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
3	CO3	**3**	**2**	**3**	**2**	**2**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
4	CO4	**3**	**2**	**3**	**2**	**2**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Fundamentals of antenna and antenna parameters:** Antenna Characteristics: Radiation Pattern, Beam Width; Radiation Resistance and efficiency; Directivity and Gain, Impedance, VSWR, Polarization; Effective height and Receive Aperture; Noise Temperature of Antenna. Radiation fields and Characteristics of λ/2 dipole; discussion on λ/4 monopole antenna; Current distribution and Radiation patterns of center-fed dipoles of length λ, 3λ/2 and 2 λ. Horizontal and Vertical antennas over a plane ground.	**15**	**CO1**
II	**Array antenna:** Antenna Arrays: electric Field due to 2 element arrays, 3 element Arrays; Pattern Multiplication; Uniform Linear Array: End fire and Broad side; Phased array.	**6**	**CO2**
III	**Analysis of different types of antenna:** Compute the input and mutual impedance of the antennas, Characteristics and properties of :Travelling Wave Antenna, Helical Antenna, Folded Dipole, Yagi-Uda Array, Loop Antenna, Electrically Short Antennas, Broad Band Antenna (Log periodic Antenna), Microstrip Patch Antenna. Radiation from an aperture: Sectoral and Pyramidal Horn Antennas, Design of Optimum Horn Antenna; Parabolic and Corner Reflectors and feed systems.	**15**	**CO3**
IV	**Propagation characteristics:** Methods of Propagation: Ground Wave Propagation, Components of ground wave, Field strength dependence on physical factors. Sky wave Propagation, Ionospheric Layers, Virtual Height, Critical Frequency, MUF, Skip distance, Sporadic Reflections. Space wave propagation: Tropospheric Scatter, Ducting Super refraction, Sub refraction. Friss Transmission Formula, SNR of a Radio Link. Physical (Medium) effects on Radio wave Propagation: Absorption, Refraction and Radio Horizon, Diffraction, Multipath Propagation and fading, Noise, Doppler effect.,to study impedance characteristics of antennas.	**8**	**CO4**
Total Hours		**44**	

Essential Readings

1. J. D. Kraus and R. J. Marhcfka, “Antenna for all application", Tata- MacGraw Hill, 3rd Edition, 2002.
2. C. A. Balanis, “Antenna Theory: Analysis & Design”, John Wiley & Sons, 3rd Edition, 2005.
3. A. R. Harish, M. Sachidananda, “Antennas and Wave Propagation”, Oxford University Press,4th Edition, 2007.

Supplementary Readings

1. E. C. Jordan, K. G. Balmain, “Electromagnetic Waves & Radiating Systems”, Prentice-Hall, 2nd Edition, 2007.
2. G. S. N. Raju, “Antennas and Wave Propagation”, Pearson Education, 1st Edition, 2014.
3. C. A. Balanis, “Modern Antenna Handbook”, John Wiley & Sons, 3rd Edition, 2007.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 314	**Data Communication and Networks**	**3**	**1**	**0**	**4**	**50**	**50**	**100**	**200**

Course Objectives	
	To introduce communication network architecture
	To teach the utility of the layered architecture
	To develop an ability and skill to design various communication networks
	To develop an ability and skill to design various wired and wireless networks

Course Outcomes		
	CO1	Able to understand data communication networks and identification of its applications
	CO2	Able to relate the TCP/IP layer model with real-life data communication
	CO3	Able to analyze the requirements for an organizational network layout and give the most appropriate networking architecture and technologies suited
	CO4	Able to design a computer communication network (Such as LAN) and having a working knowledge of connectionless and connection-oriented protocols and their security features.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**3**	**1**	-	-	-	-	-	-	-	-	**3**	-	**2**	**3**
2	CO2	**2**	**2**	-	**1**	-	-	-	-	-	-	-	-	**2**	-	**3**	**2**
3	CO3	**3**	**3**	**2**	**1**	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**	**2**
4	CO4	**2**	**2**	**2**	-	**2**	**2**	-	-	-	-	-	-	**2**	**3**	**2**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Data Communication and Networking Overview:** A Communication Model, Data Communication, Data Communication Networking Concept, ISP, Topology and Transmission Media, Concept of Client and Server, An Example Configuration. **Protocol Architecture:** The Need for Protocol Architecture, A Simple Protocol Architecture, OSI Reference Model, The TCP/IP Protocol Architecture.	**08**	**CO1, CO2**
II	**Digital Data Communication Issues:** Asynchronous and Synchronous Transmission, Concept of Frames and Packets, Types of Errors, Error Detection, Error Correction, Line Configurations, Interfacing, Physical, Logical and Port Address	**08**	**CO1, CO2**
III	**Data Link Layer** Data Link Control Medium Access Control (Mac) And Logical Link Control (LIC) Sub layer Issues, Flow Control, Error Control, Sliding Window Protocol, Polling, High-Level Data Link Control (HDCL), Performance Issues. **Local Area Network Overview:** LAN Protocol Architecture, Bridges, Emergence of High Speed LANs, Ethernet, Token Bus, Token Ring, Wireless LAN Technology (Wi-Fi).	**10**	**CO2, CO3**
IV	**Routing And Congestion Control In Switched Networks:** Routing In Circuit-Switching Networks, Routing In Packet-Switching Networks, Broadcasting, Multicasting, Flooding, Routing Algorithm, Effects of Congestion, Congestion Control In Packet Switching Networks. **Internetwork Protocols:** Basic Protocol Functions, Principles Of Internetworking, Fragmentation Concept, Connectionless Internetworking, Gateway And Routers, IPv4, Subnet, The Internet IPv6. **Transport Protocols:** Quality of Service Parameter, TCP And UDP Protocols.	**12**	**CO4**
V	**Network Security:** Security Requirement and Attacks, Confidentiality With Encryption, Message Authentication and Hash Functions, Public-Key Encryption and Digital Signatures. **Distributed Applications**: File Transfer Protocol (FTP), Electronic Mail - SMTP and MIME, Hyper Transfer Protocol (HTTP), Network Management - SNMP, Domain Name Server (DNS), URL, WWW, ATM And ISDN Networks	**10**	**CO3, CO4**
	Total Hours	**48**	

Essential Readings

1. Behrouz A. Forouzen , "Data Communications and Networking", 4th ed.,Tata Mcgraw-Hill, 2007.
2. William Stalling, "Data and Computer Communications", 8th ed. PHI, 2006.

Supplementary Readings

1. Andrew S. Tanenhaun , "Computer Networks", 5th ed.,PHI, 2014.
2. Garcia Leon and Widjaja , "Communication Networks", 2nd ed. Tata Mcgraw-Hill, 2004.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electrical and Electronics Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 320	**Control Systems**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To introduce the basic concepts, elements and terminologies of control systems		CO1	Acquire knowledge about the control systems, its applications.
	To model and discuss different physical systems (plants) in Laplace and state-space frameworks.		CO2	Obtain the mathematical models of dynamic systems in transfer function and state-space forms.
	To study the performance and stability of LTI systems in time and frequency domains.		CO3	Analyse and define the LTI system performance and stability in both time-domain and frequency domain.
	To discuss and design compensators/ controllers using analytical and graphical techniques.		CO4	Compute the Root locus and design the appropriate compensator using Root locus technique.
			CO5	Compute Bode, Nyquist plots and design the appropriate compensator using Bode plot technique.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**-**
2	CO2	**1**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**-**
3	CO3	**2**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**1**	**-**
4	CO4	**2**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**1**	**-**
5	CO5	**2**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**1**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Basic Concepts** Basic definition, basic elements of control system, open loop control system, closed loop control system, control system terminology, manually controlled closed loop systems, automatic controlled closed loop systems, basic elements of a servo mechanism, electrical analogue of multidisciplinary systems, Notion of Feedback.	**05**	**CO1**
II	**Modelling and Representations of Control Systems** Ordinary Differential Equations, derivation of transfer functions of physical systems, block diagram representation of physical systems, signal flow graphs, conversion of block diagram to signal flow graph, block diagram reduction technique, signal flow graph Manipulation using Mason's gain formula. State-Space Representation of physical systems.	**07**	**CO2**
III	**Linear System Performance in Time and Frequency Domain** Standard test signals, significance of system impulse response, Transient step response analysis of zero, first and second order systems and determination of different time domain performance specification, steady state error analysis for Type-0, Type-1 and Type-2 systems, static and dynamic errors coefficients, and errors criteria, significance of system sinusoidal response, Frequency response analysis of first and second order system, link between time and frequency domain response, Effect of addition of poles and zeros on system time response.	**09**	**CO1, CO3**
IV	**Stability of LTI Systems** Fundamental concepts of LTI system stability, Definitions of stability: BIBO stability, Absolute stability, relative stability, limited stability, asymptotic stability etc., Determination of closed loop control system stability from characteristic equation: Routh stability criterion, Hurwitz stability criterion.	**05**	**CO1, CO3**
V	**Graphical Techniques for Measurement of System Relative Stability** The Root-Locus concepts, Construction of Root Loci, Root contour, Frequency domain techniques: Bode-plot, Polar-plot, Nyquist plot, Nyquist Stability Criterion for open loop stable and unstable systems, concept of Gain Margin, Phase Margin, Closed loop frequency response.	**07**	**CO4, CO5**
VI	**Compensator Design** Introduction, different types of compensators, design of lag, lead, lag-lead compensators using root locus and Bode diagrams, design of P, PI, PD and PID controllers by analytical method, frequency response method and root locus technique.	**07**	**CO4, CO5**
	Total Hours	**40**	

Essential Readings

1. K. Ogata, "Modern Control Engineering", PHI, 5th edition, 2010.
2. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 6th edition, 2018

Supplementary Readings

1. N. S. Nise, "Control System Engineering", Wiley India, 2018
2. R. C. Dorf, R. H. Bishop, "Modern Control Systems", Pearson, 12th edition, 2010
3. B. C. Kuo, "Automatic Control Systems", Wiley India, 9th edition, 2014

	National Institute of Technology Meghalaya An Institute of National Importance		CURRICULUM
Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 322	**Advanced Digital Signal Processing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To study the fundamentals of sampling theory and multi-rate signal processing.		CO1	Ability to understand the fundamentals of sampling theory and multi-rate signal processing.
	To study the different linear prediction and optimum linear filters.		CO2	Ability to understand the different linear prediction and optimum linear filters.
	To study different adaptive filters.		CO3	Ability to understand the different adaptive filters.
	To study the various nonparametric methods for power spectrum estimation.		CO4	Ability to analyse the various nonparametric methods for power spectrum estimation
	To study the various parametric methods for power spectrum estimation.		CO5	Ability to analyse the various parametric methods for power spectrum estimation

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**1**	**1**	**-**
2	CO2	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**2**	**-**
3	CO3	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**1**	**2**	**-**
4	CO4	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**2**	**-**
5	CO5	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**2**	**-**

SYLLABUS

No.	Content	Hours	COs
I	Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for Sampling rate Conversion. Multistage Implementation of Sampling Rate Conversion, Applications of Multirate Signal Processing, Sampling Rate Conversion of Bandpass Signals.	**7**	**CO1**
II	Linear Prediction and Optimum Linear Filters Innovations Representation of a Stationary Random Process, Forward and Backward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters.	**7**	**CO2**
III	Adaptive Filters Adaptive direct-form FIR Filters- LMS Algorithms, Adaptive Direct-Form Filter- RLS Algorithms, Adaptive Lattice-Ladder Filters.	**7**	**CO3**
IV	Power Spectral Estimation Estimation of Spectra from Finite Duration Observations of a Signal, Periodogram, Nonparametric Methods for Power Spectral Estimation: Bartlett, Welch, Blackman and Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods.	**7**	**CO4**
V	Parametric Methods for Power spectrum estimation Relationship between Auto-Correlation and Model Parameters, Yule-Walker method for AR model parameter, Burg method for AR model parameter, Unconstructrained Least Squares Methods for AR model parameter, Sequential Estimation methods for AR model parameter, Moving Average(MA) and ARMA Models Minimum Variance Method.	8	**CO5**
Total Hours		**36**	

Essential Readings

1. Proakis JG and Manolakis DG, "Digital Signal Processing Principles, Algorithms and Application", Pearson, 4rd edition, 2007
2. Openheim AV and Schafer RW, "Discrete Time Signal Processing", Pearson, 3rd edition, 2010.

Supplementary Readings

1. Gopi ES, "Algorithm collections for Digital Signal Processing Applications using Matlab", Springer, 1st edition, 2007.

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Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 324	**DSP Systems & Architectures**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To study digital representation of Various number systems		CO1	Describe the different representation of number systems
	To understand the redundant and residue number system and application		CO2	Concept of redundant number and residue number system and implementation concept
	To understand the concept of binary addition, multiplication and division circuits		CO3	Familiarization of different adder architectures
	To understand concept of floating point arithmetic		CO4	Familiarization of different architectures of multipliers and dividers
	To understand the concept of floating point arithmetic circuits		CO5	Familiarization with floating point number representation in digital domain and architectures of floating point circuits
			CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	-	-	**1**	**1**	**3**	-	-	-	-	-	-	**3**	-	**3**
2	CO2	-	-	-	**3**	**2**	**3**	-	-	-	-	-	-	-	**2**	**2**
3	CO3	-	-	**3**	**2**	**2**	**3**	-	-	-	-	-	-	-	**3**	**2**
4	CO4	-	-	-	-	-	-	**3**	**3**	-	-	-	-	**2**	**3**	**2**
5	CO5	-	-	-	-	-	-	-	**3**	**2**	-	-	-	**3**	**3**	**3**
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**DSP Integrated Circuits** Introduction, Digital Signal Processing, Standard Digital Signal Processors, Application Specific ICs for DSP, DSP Systems, DSP System Design, Integrated Circuit Design.	**08**	**CO1**
II	**Digital Signal Processing** The Fourier Transformation, The Z Transformation, Sampling of Analog Signals, Selection of Sampling Frequency, Signal Processing Systems, Difference Equation, Frequency Response, Transfer Function, Filter Structure, DFT and FFT, Adaptive DSP Algorithm, DCT.	**10**	**CO2**
III	**DSP Algorithm** DSP Systems, Precedence Graph, SFG in Precedence Form, Difference Equation, Computation Graph, Equivalence Transformation, Interleaving and Pipelining, Algorithm Transformation, Mapping Technique, Scheduling, Scheduling Formulation, Resource Allocation, Resource Scheduling, Interpolator	**10**	**CO3**
IV	**DSP System Architectures** Standard DSP Architecture, TMS 32series, Ideal DSP Architecture, Multiprocessor, Multicomputer, Systolic Array, Wave Front Array, Shared Memory Architecture.	**08**	**CO4**
VII			
	Total Hours	**36**	

Essential Readings

1. L. Wanhammer, “DSP Integrated Circuits”, Academic Press, 1st Edition, 1999
2. U. Meyer-Baese, “Digital Signal Processing with Field Programmable Gate Arrays”, Springer Publications, 1st Edition, 2001

Supplementary Readings

1. M. D. Ercegovac, Digital Arithmetic, The Morgan Kaufmann Series in Computer Architecture and Design. 1st Edition, 2003.
2. D. A. Patterson and J. L. Hennessy, Computer Organization and Design, Morgan Kaufmann Publishers Inc. San Francisco, 5 th Edition, 2014.
3. A. V. Oppenheim, R.W. Schafer, “Discrete Time Signal Processing”, Prentice Hall Publication, 3rd Edition, 2014.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-2019**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	Continual Evaluation	VIVA	Total
EC 352	**Digital and Analog Integrated Circuits Lab**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	Course Outcomes		
To understand Spice Simulation of Circuits		CO1	Design of circuits using Spice simulator
To understand the amplifier characteristics		CO2	Design of amplifier using Spice simulator
To develop an ability of CMOS Circuits		CO3	Able to design of CMOS digital circuits
To develop the CMOS Circuits Layouts		CO4	Able to analyse CMOS Inverter
		CO5	Able toanalyse the VTC and layout of CMOS inverter
		CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	-	**1**	**1**	-	-	-	-	-	-	-	-	**3**	-	**3**
2	CO2	-	**3**	**2**	**1**	-	-	-	-	-	-	-	-	**2**	-	**2**
3	CO3	-	-	**3**	-	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**
4	CO4	-	**2**	**3**	-	-	-	-	-	-	-	-	**1**	**2**	**3**	**2**
5	CO5	-	-	**3**	**2**	-	-	-	-	-	-	-	**1**	**3**	**3**	**3**
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to SPICE Circuit Simulator.**	**4**	**CO1**
II	Inverting and Non-Inverting Amplifier. Summing, Scaling and Averaging. Integrator and Differentiator	**6**	**CO2**
III	Implementation of CMOS Inverter. Obtain & Plot Its Transfer Characteristics, Determine Noise Margins and Measure Propagation Delay. Realization of MOSFET Characteristics Using Circuit Simulator Characteristics and BSIM Models. Realization of CMOS logic Gates.	**4**	**CO2, CO3**
IV	Realization of CMOS Half Adder & Full Adder Circuit.	**2**	**CO2, CO3**
V	Design and Implement of 1-Bit RAM CELL using JK & SR Flip-Flop.	**2**	**CO4, CO5**
VI	Layout of CMOS Inverter and Parasitic Extraction and Obtain VTC of Extracted Net List	**4**	**CO2, CO4**
	Total Hours	**22**	

Essential Readings

1. S-M. Kang and Y. Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", Tata McGraw-Hill, 3rd Edition, 2002
2. B. Razavi, “Design of Analog CMOS Integrated Circuit” Tata McGraw-Hill, 2rd Edition, 2017

Supplementary Readings

1. H. Taub and D. Schilling, "Digital Integrated Electronics", McGraw-Hill, International, 2017.
2. R. Jan, A. Chandrakasan, and B. Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition 1999.
3. S. Salivahanan S., "Linear Integrated Circuits", McGraw-Hill, 3rd Edition, 2018

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Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution		
		L	T	P	C	CONTINUOS EVALUATION	VIVA	Total
EC 354	**RF & Microwave Engineering Laboratory**	**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	
	To develop the student's ability to understand the Microwave bench and filters.
	Develop the understanding of the characteristics of microwave devices.
	To develop the analytical understanding of waveguides and their boundary condition.

Course Outcomes		
	CO1	Will develop understanding on Microwave bench and analyse microwave filter using simulation tool
	CO2	Will develop understanding on microwave devices and analyse its characteristics
	CO3	Implement a waveguide using simulation tools and develop understanding on boundary condition
	CO4	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**2**	**1**
2	CO2	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**2**	**1**
3	CO3	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**3**	**1**	**2**	**2**	**3**	**3**	**1**
4	CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	Introduction on Microwave Bench.	**14**	**CO1, CO2, CO3**
II	To Study Microstrip Band Pass and Band Stop Filters.		
III	To Plot V-I Characteristics Of Gunn Diode.		
IV	To Plot Mode Characteristics Of Reflex Klystron.		
V	To Study Fundamental Mode of Rectangular waveguide		
VI	To Study Effect of Metallic Post Loading on Rectangular waveguide		
VII	To Study Effect of Drilling Hole Along Broad Wall & Narrow Wall Direction of Waveguide Using Electromagnetic Boundary Condition		
	Total Hours	**14**	

Essential Readings

1. L. Samuel Y., "Microwave Devices and Circuits", PHI, 3rd Edition,2014
2. F. Gustrao, "RF & Microwave Engineering", Wiley, 2nd edition, 2012

Supplementary Readings

1. D. Annapurna and D. Sisir K., "Microwave Engineering", Tata McGraw-Hill, 3rd Edition, 2017
2. S. Merril I., "Introduction to Radar Systems", Tata McGraw-Hill, 3rd edition, 2014
3. R.S. Rao, "Microwave Engineering", PHI, 2nd Edition, 2012
4. D. M. Pozar, "Microwave Engineering", Wiley, 4th Edition, 2011

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 372	**Basics of communication systems**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	To familiarize the fundamentals of analog communication.	Course Outcomes	CO1	Ability to understand the fundamentals of analog communication.
	To familiarize the fundamentals of digital communication.		CO2	Ability to understand the fundamentals of digital communication.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
2	CO2	**3**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**2**	**1**	**-**
3	CO3	**3**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**2**	**2**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** Basic Blocks in a Communication System: Transmitter, Channel and Receiver, Baseband and Passband Signals and their Representations, Concept of Modulation and Demodulation, Signal Transmission through a Linear System, Signal Distortion over a Communication Channel. Amplitude modulation (AM) - Double Sideband (DSB), Double Sideband Suppressed Carrier (DSB-SC) Amplitude Modulation, Single sideband (SSB) Amplitude Modulation, Vestigial Sideband (VSB) Amplitude Modulation, Local Carrier Synchronization, Frequency Division Multiplexing, Phase Looked Loop and Some Applications. Nonlinear Modulation, Bandwidth of Angle Modulated Waves, Generating Frequency modulation (FM) Waves, Demodulation of FM Signals, Effects of Nonlinear Distortion and Interferences, Super-Heterodyne Analog AM/FM Receivers, FM Broadcasting System.	**12**	**CO1, CO2**
II	**Digital communication** Sampling Process, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Quantization Techniques, Pulse Code Modulation (PCM), Differential Pulse Code Modulation, Adaptive Differential Pulse Code Modulation, Delta Modulation, Adaptive Delta Modulation. Baseband transmission: intersymbol interference, noise, eye pattern, BER analysis, Optimum filtering, equalization techniques; Clock recovery; Line coding techniques: Binary and multilevel line codes, Basic Digital modulation schemes: Binary modulation schemes- ASK, PSK, FSK, and DPSK.	**13**	**CO2, CO3**
Total Hours		**25**	

Essential Readings

1. Lathi B. P and Ding Zhi, “Modern Digital and Analog Communication Systems”, Oxford University Press, 4th edition, 2017
2. Proakis J and Salehi M, “Fundamental of Communication Systems”, Pearson, 2nd edition, 2006.

Supplementary Readings

1. S. Haykin, “Communication Systems”, John Wiley & Sons, 4th edition, 2001.
2. Leon W. Couch, II, "Digital and Analog Communication Systems," Pearson Education, 6th edition, 2004.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VI**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 374	**Designing IoT Platform with Arduino & Pi**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**100**

Course Objectives	To understand basic of IoT, Arduino and Pi	Course Outcomes	CO1	Design of circuits using Arduino
	To develop the Arduino based applications		CO2	Able to analyse the bugs in the Arduino
	To develop an interface between Arduino and Pi		CO3	Able to interface Arduino & Pi
			CO4	Design of IoT platform through Arduino & Pi

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	-	-	-	-	-	-	-	-	-	-	-	**3**	-	**3**
2	CO2	-	**3**	-	-	-	-	-	-	-	-	-	-	**2**	-	**2**
3	CO3	**2**	-	**3**	-	-	-	-	-	-	-	-	-	**2**	**3**	**2**
4	CO4	-	**2**	**3**	-	-	-	-	-	-	-	-	**1**	**2**	**3**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction – Digital and analog signals, Sensors (temperature, accelerometer, IR, Obstacle, ultrasonic), communication modules, LCD display, data processing units**	**6**	**CO1**
II	**Arduino-** Interfacing analog and digital sensors, interfacing Wifi, BLE and Zigbee modules, Data collection.	**6**	**CO1, CO2**
III	**Raspberry Pi-** communication facilities on raspberry pi (I2C, SPI, UART), working with GPIO library, Interfacing of sensors and actuators, Teraterm communication	**6**	**CO3**
IV	**Interfacing Pi and Arduino**	**2**	**CO3, CO4**
V	**Case Study – IoT platform design for soil moisture sensors.**	**4**	**CO3, CO4**
	Total Hours	**24**	

Essential Readings

1. M. margolis, “Arduino cookbook ,“ O'Reilly Media, Inc.,2nd edition, 2011
2. E. Upton and G. Halfacreee, “ Raspberry pi user guide,” John Wiley & Sons, 2nd edition, 2012

Supplementary Readings

1. G. Mitnick, "Raspberry Pi 3: Learn to Use Raspberry pi 3! An Introduction to Using with Python, Scratch, JavaScript and More", CreateSpace Independent Publishing Platform, 1st edition, 2017.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-2019**
Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 411	**VLSI Design**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To study the flow chart of ASICs and FPGAs		CO1	Describe the different phases of the design flow for digital ASICs
	To understand the Propagation delay and Power consumption of CMOS		CO2	Understand basic clocking issues
	To develop the subsystem for Digital VLSI circuits		CO3	Familiarize with CAD tool capabilities and limitations
	To understand the digital circuits With VHDL		CO4	Use automatic synthesis, placement and routing tools to implement a design
	To understand the concept of synthesize of digital circuits		CO5	Able to analyse and design of CMOS digital circuits
			CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	-	**1**	**1**	**1**	-	-	-	-	-	-	-	**3**	-	**3**
2	CO2	-	**3**	**2**	**1**	-	-	-	-	-	-	-	-	-	**2**	**2**
3	CO3	-	-	**3**	**2**	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**
4	CO4	-	**2**	**3**	-	-	-	-	-	-	-	-	-	**2**	**3**	**2**
5	CO5	-	-	**3**	**2**	**2**	-	-	-	-	-	-	-	**3**	**3**	**3**
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to VLSI design** Application specific Integrated circuits (ASICs) , VLSI Design Styles, VLSI Design Flow, Design Hierarchy, PLA, PAL, PLD and CPLD.	**04**	**CO1**
II	**Propagation delay & delay equations** Delay definition, Propagation delay of CMOS inverter chain, Delay equation: Switching resistance, input & output capacitance Delay sensitivity to channel length, width & gate-oxide thickness. Delay sensitivity to power supply, Delay sensitivity to parasitic resistance & capacitance, Calculation of interconnect delay, Elmore delay	**06**	**CO2**
III	**Power consumption in CMOS circuits** Dynamic/switching power, Static / Leakage power, Short circuit power	**04**	**CO2, CO3**
IV	**Sub System Design** Circuit techniques for low power design, Low voltage low power Adders, Low voltage low power Multipliers Low voltage low power ROM	**04**	**CO3, CO4**
V	**Digital modeling and simulation with VHDL** Introduction to VHDL, Basic Language Elements, Structural modeling, Data-flow modelling, Behavioral styles of modeling. Basic language elements. Entities, architecture specification and configurations. Syntax and Semantics of VHDL. Variable and signal types, arrays and attributes. Operators, expressions and signal assignments. Packages & Libraries. Component instantiation. Synthesis. Timing Simulation. Use of Procedures and functions, Examples of design using VHDL.	**06**	**CO1, CO2, CO3, CO4**
VI	**FPGA concept, architecture and programming** Introduction to ASICs and FPGAs; Fundamentals in digital IC design FPGA & CPLD Architectures; FPGA Programming Technologies; FPGA Logic Cell Structures; FPGA Programmable Interconnect and I/O Ports; FPGA Implementation of Combinational Circuits; FPGA Sequential Circuits; Timing Issues in FPGA Synchronous Circuits	**07**	**CO1, CO4**
VII	**Physical design automation (Placement, Floor Planning, Routing)** Basics of Layout: Design rule, Layout design of CMOS circuits, Circuit partitioning, Placement & routing algorithm, Design rule verification	**07**	**CO5**
	Total Hours	**38**	

Essential Readings

1. M. Sarrafzadeh and C. K. Wong, “An Introduction to VLSI Physical Design”, McGraw Hill, 1st Edition, 1996
2. P. Ashenden, “Digital Design using VHDL”, Elsevier, 1st Edition, 2007

Supplementary Readings

1. P.J Anderson, “The designer’s guide to VHDL”, Morgan Kaufman, 1st Edition, 2008
2. N.H.E. Weste, K. Haase, D. Harris, A. Banerjee, “CMOS VLSI Design: A circuits and Systems Perspective”, Pearson Education, 4th Edition, 2011
3. W.Wolf , “FPGA System design”, Pearson, 1st Edition, 2004
4. S. H. Gerez, “Algorithms for VLSI design automation”, Wiley, 1st Edition, 1998

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 413	**Biomedical Image Processing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	To study the fundamentals of digital image processing.	Course Outcomes	CO1	Ability to understand the various medical images and their difference.
	To study the various pre-processing techniques used in Biomedical image processing.		CO2	Ability to learn different image enhancement techniques used for medical images.
	To study the various segmentation techniques used in Biomedical field.		CO3	Ability to learn various medical image segmentation techniques.
	To develop the skill for practical problems solving using various algorithm in the field of medical Images.		CO4	Ability to study the various feature extraction techniques and classifier models for biomedical images.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**	**-**
2	CO2	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**-**
3	CO3	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**-**
4	CO4	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**	**-**

SYLLABUS

No.	Content	Hours	COs
I	Fundamentals of Image processing and Image Transforms, Basic steps of Image processing system, Sampling and Quantization of an Image, Basic relationship between Pixels, Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms, Various Medical images : X-ray and Computed Tomography (CT) imaging, Magnetic Resonance Imaging (MRI), Ultrasonic Imaging, Microscopic Imaging.	**10**	**CO1**
II	Image Enhancement: Gray scale thresholding, Contrast manipulation, histogram equalization, Laplacian derivatives, rank operators – textural analysis, Homomorphic filtering.	**6**	**CO2**
III	Segmentation: Edge Detection, Optimal thresholding, Region based segmentation (splitting and merging), K-means clustering based segmentation, Fuzzy based segmentation	**10**	**CO3**
IV	Representation of shapes and countours, shape factors, Fourier Descriptors, Difficulties in biomedical image acquisition and analysis and various classifier models for medical applications: SVM, ANN, Naïve Bayes, k-NN	**12**	**CO4**
	Total Hours	**38**	

Essential Readings

1. Gonzalez R. C. and Woods R. E, "Digital Image Processing", Pearson Prentice Hall, 2nd edition, 2002.
2. Rangaraj M. Rangayyan, “Biomedical Image Analysis”, CRC Press, 2000.
3. Qiang Wu, Fatima A. Merchant, Kenneth R. Castleman, “Microscope Image Processing”, Elsevier Publication, ISBN: 978-0-12-372578-3.

Supplementary Readings

1. Gonzalez R. C, Woods R. E and Eddins S. L "Digital Image Processing using MATLAB", McGraw Hill Education, 2nd edition, 2017.
2. Richard O. Duda, Peter E. Hart, David G. Stork. Pattern classification, Wiley, New York, 2001.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 415	**Wireless Communication**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To provide students an understanding of the concepts related to wireless channel modelling.		CO1	Able to model the wireless channel in terms of large scale/small scale fading, delay spread, coherence time parameters and understand the basic concepts of Cellular System and the design requirements
	To explore communication concepts and techniques for exploiting wireless channel characteristics and application of these concepts in a system context.		CO2	Able to gain insights into various mobile radio propagation models and the fading effects on the system performance
	To familiarize students on how the diversity can be exploited to improve performance		CO3	Able to analyse the effectiveness of diversity techniques to mitigate the multichannel fading effects on received signals with insights on MIMO technology and spectral efficiency improvements through spatial multiplexing
	To familiarize students with capacity analysis and multiple access techniques in 3G, 4G and 5G		CO4	Enabling the students to think in terms of innovative ideas to improve the existing technology in the field of wireless communication through improving capacity in cellular systems and allocating resources in multiuser scenarios

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**3**	**-**
2	CO2	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**1**	**2**	**-**
3	CO3	**1**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**3**	**-**
4	CO4	**1**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**2**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Overview on wireless systems:** Motivation and introduction for wireless communication, The cellular concept fundamentals: cell capacity and reuse, Introduction to 3G, 4G and 5G technologies.	**04**	**CO1**
II	**Wireless propagation models and fading:** Large scale path loss - Free-space propagation model, propagation path loss, outdoor propagation models (Okumura model & Hata model), combined pathloss and shadowing. Small scale and multipath fading - AWGN Channel, multipath fading, flat and frequency selective fading, BER performance for various modulations, slow and fast fading, delay spread and coherence bandwidth, Rayleigh, Rician and Nakagami channel models.	**09**	**CO2**
III	**Diversity & Combining Techniques:** Introduction to SIMO, MISO, MIMO, Realization of independent fading paths, Receiver diversity: selection combining (SC), threshold combining, maximum ratio combining (MRC), equal gain combining (EGC), Transmitter diversity: channel known at transmitter, channel unknown at the transmitter, the Alamouti scheme, BER performance of all above schemes, Spatial Multiplexing in MIMO, Singular Value Decomposition of Channel, Optimal Power Allocation, MIMO Zero-Forcing and MMSE Receivers.	**09**	**CO3**
IV	**Capacity of wireless channels:** AWGN channel capacity, capacity of fading channels – slow fading channel, receive diversity, transmit diversity, time and frequency diversity, fast fading channel, transmitter side information, frequency selective fading channels	**06**	**CO4**
V	**Multiuser communication, multiple access techniques –** Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Global System for Mobile (GSM) communication, Introduction to wide band communication systems - Code Division Multiple Access (CDMA), Orthogonal Frequency-Division Multiplexing (OFDM) and Orthogonal Frequency Division for Multiple Access (OFDMA), Single Carrier FDMA schemes, Introduction to MIMO-OFDM, Long Term Evolution (LTE)	**08**	**CO3, CO4**
	Total Hours	**36**	

Essential Readings

1. T.S. Rappaport, "Wireless Communications – Principles and Practice", 2nd edition, Pearson, 2010.
2. D. Tse and P. Vishwanath, "Fundamentals of Wireless Communications", Cambridge Univ Press, 2005.
3. A. Molisch, "Wireless Communications", Wiley, 2005.

Supplementary Readings

1. A. Goldsmith, "Wireless Communications", Cambridge Univ Press, 2005
2. William C.Y. Lee, "Wireless and Cellular Telecommunications," Third edition, Mc. Graw Hill, 2006
3. Aditya K. Jagannatham, "Principles of Modern Wireless Communications Systems" McGraw Hill Education, 1st edition, 2015.
4. NPTEL Video Lectures on Advanced 3G and 4G Communication

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 417	**High Band Gap Device Modelling**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	High bandgap Semiconductor (Especially III-V) basics and comparison with silicon		CO1	Able to understand basics of high bandgap semiconductor model.
	High bandgap Semiconductor device basics		CO2	Able to learn basic of process modelling.
	Basics of III-V device (Especially HEMT & HBT)		CO3	Able to learn basic of electrical modelling.
	III-V device (Especially HEMT & HBT) models		CO4	Able to do various device level modelling like analytical, empirical and LUT.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**
2	CO2	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**High Bandgap Semiconductor Material modelling:** Introduction of density functional theory (DFT) tool and atomistic tool kit (ATK). Difference between Silicon and the high bandgap semiconductor, Impact and modelling of epitaxial crystal, Interfaces, Hetero junction interface and Homo junction interface, Bandgap engineering, defects, trap, dislocation.	**8**	**CO1**
II	**High Bandgap Semiconductor Process modelling:** Introduction of technology computer aided design (TCAD) tool emphasis on process. Various process technology like etching, photolithography, deposition, and masking models and tools	**6**	**CO2**
III	**High Bandgap Semiconductor Device modelling :** Introduction of technology computer aided design (TCAD) tool emphasis on electrical properties. IV and CV curves determination. Power and RF parameter analysis. 9 steps of device modelling. These 9 steps are abbreviated as SQEBASTIP where S stands for structure and characteristics to scale Q for qualitative model E and B for equations and boundary conditions A and S for approximations and solution, T for testing of the solution and I for improvement and finally P for parameter extraction.	**10**	**CO3**
IV	**Analytical modelling of the device** Physics equation based modelling, solution of Schrodinger and Poisson equation solution. Use of matlab or any mathematical tool for the demonstration of analytical model.	**6**	**CO4**
V	**Empirical modelling and LUT based model of the device:** Fundamental of empirical model and LUT based model. Implementation of these models in the circuit simulator like ADS or Cadence tool.	**6**	**CO4**
	Total Hours	**36**	

Essential Readings

1. M. Lundstrom,"Fundamentals of Carrier Transport", Cambridge University Press, 2nd Edition, 2000.
2. C.Snowden,"Introduction to Semiconductor Device Modeling", World Scientific, 1st Edition,1998.

Supplementary Readings

1. B.J Baliga, Wide Bandgap Semiconductor Power Devices: Materials, Physics, Design, and Applications, Woodhead Publishing, 1st Edition, 2019.
2. Y. Tsividis and C. McAndrew, "MOSFET modeling for Circuit Simulation", Oxford University Press, 1st Edition, 2011.

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Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 421	**VLSI Signal Processing**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	
	To study high level architectures of hardware specific systems
	To understand concept of digital signal processor architecture
	To develop the subsystem for Digital signal processors
	To understand the convolution processors
	To understand the concept filter design techniques in VLSI

Course Outcomes	
CO1	Describe the hardware description language, FPGA design concept
CO2	Understand architectural issues of digital signal processors
CO3	Familiarize discrete Fourier transformation processor in FPGA
CO4	Convolution architecture design in FPGA
CO5	Filter design techniques w.r.t VLSI circuits
CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	-	-	**1**	**1**	**1**	**3**	-	-	-	-	-	-	**3**	-	**3**
2	CO2	-	**3**	**2**	**1**	**3**	-	-	-	-	-	-	-	-	**2**	**2**
3	CO3	-	-	-	**2**	**2**	-	**3**	-	-	-	-	-	-	**3**	**2**
4	CO4	-	**2**	**3**	-	-	-	-	-	-	-	-	-	**2**	**3**	**2**
5	CO5	-	-	-	**2**	**2**	-	**3**	-	-	-	-	-	**3**	**3**	**3**
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Digital systems** Digital system design options and trade-offs, Design methodology and technology overview, High Level System Architecture and Specification, Behavioral modeling and simulation. Fixed and Floating point systems Hardware description languages, combinational and sequential design, state machine design, synthesis issues, test benches. Overview of FPGA architectures and technologies: FPGA Architectural options, granularity of function and wiring resources	**10**	**CO1**
II	**Architectural issues in DSP** Linear system theory, DFT, FFT, realization of digital filters. Data flow graph representation of DSP algorithm. Binary Adders, Binary multipliers, Multiply Accumulator (MAC) and Sum of Product (SOP). Pipelining and Parallel Processing, Retiming, Unfolding, Folding, Systolic, Distributed arithmetic, Cordic architecture design.	**12**	**CO2, CO3**
III	**Fast Convolution** Cook-Toom algorithm and modified Cook-Toom algorithm, Winograd algorithm, modified Winograd algorithm, Algorithmic strength reduction in filters and transforms, DCT and inverse DCT, parallel FIR filters and analysis of finite word length effects	**08**	**CO3, CO4, CO5**
IV	**Design of Low Power Filters** Scaling versus power consumption, power analysis, power reduction techniques, power estimation techniques, low power IIR filter design, Low power CMOS lattice IIR filter.	**08**	**CO4, CO5**
	Total Hours	**38**	

Essential Readings

1. K. K. Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation", John Wiley, 1st Edition, 1999.
2. U. Meyer-Baese, "Digital Signal processing with Field Programmable Arrays", Springer, 3rd Edition 2007.

Supplementary Readings

1. S. Ramachandran, Digital VLSI systems design . Springer, 2007.
2. V. K. Madisetti, "VLSI Digital Signal Processors: An Introduction to Rapid Prototyping and Design Synthesis", IEEE Press, 1st Edition, 1995.
3. S. Y. Kung, and H. J. Whitehouse, VLSI and Modern Signal Processing, Prentice Hall, 1st Edition, 1985.
4. Chan, K. Pak and S.Mourad, Digital system design using field programmable gate arrays, Prentice-Hall, Inc, 1st Edition 1994.

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Department	Electronics and Communication Engineering	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 423	Machine Learning and Speech Technology	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	Introducing of various mathematical methods involved in machine learning (ML).		CO1	Able to explain mathematical methods in developing of machine learning techniques.
	Introducing of short-time processing of speech signals and time-frequency analysis of speech signals.		CO2	Able to develop the short-term processing methods for speech analysis.
	Introducing of the fundamentals of ML techniques useful for speech processing applications.		CO3	Able to perform analysis of speech signals using time-frequency representation.
			CO4	Able to develop ML techniques for speech recognition, signal and source separation.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**1**	-	-	**1**	-	-	-	-	-	-	-	**2**	-	**1**	-
2	CO2	**1**	**2**	**2**	**2**	-	-	-	-	-	-	-	**1**	**2**	-	**2**	-
3	CO3	-	**2**	**2**	**1**	**2**	-	-	-	-	-	-	**2**	**2**	**2**	**2**	-
4	CO4	-	**2**	-	**1**	**2**	-	-	-	-	-	-	**2**	**2**	**2**	**2**	-

SYLLABUS

No.	Content	Hours	Cos
I	Refreshing of linear algebra, probability theory and digital signal processing. Machine Learning (ML) basics: supervised and unsupervised learning, classification and regression, evaluation metrics. Probability Models and Expectation Maximization Algorithm: Gaussian Mixture Models. Neural Networks and Deep Learning: multi-class classification and multi-lable classification, different kinds of non-linearities, objective functions and learning methods	**10**	**CO1**
II	Speech production and perception, information sources in speech, linguistic aspect of speech, acoustic and articulatory phonetics, nature of speech, models for speech analysis and perception; Short-term processing: need, approach, time, frequency and time-frequency analysis; Speech enhancement.	**12**	**CO2, CO3**
III	ML for audio classification: time series analysis, LSTMs and CNNs ML for speech recognition: Hidden Markov Models, finite state transducers and dynamic programming.	**08**	**CO4**
IV	ML for Music Information Retrieval: Latent Variable Models, Matrix Factorization and Signal Separation	**06**	**CO4**
	Total Hours	**36**	

Essential Readings

1. J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, “Discrete-Time Processing of Speech Signals”, WileyIEEE Press, NY, USA.
2. C.M. Bishop, "Pattern Recognition and Machine Learning", 2nd Edition, Springer, 2011.
3. I. Goodfellow, Y, Bengio, A. Courville, "Deep Learning", MIT Press, 2016.
4. D. Yu and L. Deng, "Automatic Speech Recognition: A Deep Learning Approach", Springer, 2016.

Supplementary Readings

1. L.R. Rabiner and R.W. Schafer, “Digital Processing of Speech Signals”, Pearson Education.
2. D. O’Shaughnessy, “Speech Communications: Human and Machine”, University Press.
3. T. F. Quatieri, “Discrete time processing of speech signals”, Pearson Education.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 425	**CAD for VLSI Design**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	Understand the complete design methodology of VLSI automation		CO1	Understand of VLSI Design Automation.
	Design and synthesis the basic level circuits and High level synthesis circuits		CO2	Acquire knowledge about CAD tools used for VLSI design.
	Understand Algorithms for VLSI Design Automation		CO3	Able to understanding Algorithms for VLSI Design Automation.
			CO4	Able to gather knowledge of High Level Synthesis.
			CO5	Able to perform Timing Analysis on a circuits

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	-	-	-	-	-	-	-	-	-	-	**3**	**1**	-	-
2	CO2	**2**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**1**	**2**	-
3	CO3	**2**	**3**	**2**	-	-	-	-	-	-	-	-	**2**	**2**	**1**	**2**	-
4	CO4	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-

SYLLABUS

No.	Content	Hours	COs
I	VLSI design flow, CMOS based logic design, challenges, introduction and use in synthesis, modeling combinational and sequential logic, writing test benches. two-level and multilevel gate-level optimization, state assignment of finite state machines and timing	**12**	**CO1**
II	High-level synthesis: basic concepts, partitioning, scheduling, allocation and binding. Technology mapping. Testability issues: fault modeling and simulation, test generation, design for testability, built-in self-test. Testing SoC's. Basic concepts of verification	**12**	**CO2**
III	Physical design automation: review of MOS/CMOS fabrication technology. VLSI design styles: full custom, standard-cell, gate-array and FPGA. Physical design automation algorithms: floor-planning, placement, routing, compaction, design rule check, power and delay estimation, clock and power routing, etc. Special considerations for analog and mixed-signal designs.	**12**	**CO3**
	Total Hours	**36**	

Essential Readings

1. N.A. Sherwani, “Algorithms for VLSI physical design automation”, Kluwer Academic Publishers, Ist edition, 1999
2. J. Bhasker, “Verilog VHDL synthesis: a practical primer”, B S Publications Ist edition, 1998
3. M M. Sarrafzadeh and C.K. Wong, “An introduction to physical design”, McGraw Hill, 1996
4. D.D. Gajski, N.D. Dutt, A.C. Wu and A.Y. Yin, “High-level synthesis: introduction to chip and system design”, Kluwer Academic Publishers.Ist edition 1992

Supplementary Readings

1. M.J. Sebastian Smith and A. Wesley, “Application-specific integrated circuits”, Addison-Wesley Pub, 2008
2. M.L. Bushnell and V.D. Agrawal, “Essentials of Electronic Testing”, Kluwer Academic Publishers, 2000

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Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 427	**Satellite Communication**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand the fundamentals of satellite communication and its parameters		CO1	Able to acquire the knowledge about fundamentals of satellite communication and its parameters
	To understand the concepts of satellite orbits and trajectories		CO2	Able to understand the basic concepts of satellite orbits and trajectories
	To understand basics of satellite launch vehicle, subsystem and earth station		CO3	Able to understand basics of satellite launch vehicle, subsystem and earth station
	To understand various of multiple accesses techniques		CO4	Able to understand various multiple accesses techniques

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
2	CO2	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
3	CO3	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
4	CO4	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction & fundamental parameters:** Historical background, Basic concepts, Frequency allocation for satellite services, orbital & spacecraft problems, comparison of networks and services, modulation techniques used for satellite communication	**09**	**CO1 & CO2**
II	**Satellite orbits and trajectories:** Two body problem, orbital mechanics, Orbital parameters, geostationary orbit, change in longitude, orbital maneuvers, orbital transfer, orbital perturbations, Injection velocity and satellite trajectory, Types of Satellite orbits, Orbital perturbations, Satellite stabilization, Orbital effects on satellite's performance, Eclipses, Look angles: Azimuth angle, Elevation angle	**12**	**CO1 & CO2**
III	**Satellite launch vehicle:** Launch Vehicles- principles of Rocket propulsion, powered flight, Launch vehicles for communication satellite **Satellite subsystem:** Power supply subsystem, Attitude and Orbit control, Tracking, Telemetry and command subsystem, Payload. **Earth station:** Types of earth station, Architecture, Design considerations, Testing, Earth station Hardware, Satellite tracking	**6**	**CO3**
IV	**Multiple accesses:** Introduction, FDMA (No derivation), SCPC Systems, MCPC Systems, TDMA, CDMA, SDMA	**6**	**CO4**
	Total Hours	**33**	

Essential Readings

1. D. Roddy, "Satellite Communications", Tata- MacGraw Hill, 4th Edition, 2017.
2. T. Pratt, C. Bostian, J. Allnutt, "Satellite Communications", John Wiley & Sons, 2nd Edition, 2006.
3. W.L. Pritchard, H. G. Suyderhoud, R. A. Nelson, "Satellite Communications Systems Engineering", Prentice-Hall,4th Edition, 2008.

Supplementary Readings

1. A. K. Maini, V. Agrawal, "Satellite Technology: Principles and Applications", John Wiley & Sons, 2nd Edition, 2011.
2. P. Banerjee, "Antennas and Wave Propagation", Pearson Education, PHI, 1st Edition, 2017.

	National Institute of Technology Meghalaya An Institute of National Importance	CURRICULUM
Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation: **2018-2019**
Department	**Electronics and Communication Engineering**	Semester: **VII**

Course Code	Course Name	Pre-Requisite	Credit Structure				Marks Distribution		
			L	T	P	C	Continuous Assessment	VIVA	Total
EC 451	**Computing and Simulation Lab**		**0**	**1**	**2**	**2**	**70**	**30**	**100**

Course Objectives	To introduce HDL software	Course Outcomes	CO1: Able to acquire knowledge about IC design software's
	To introduce complex logic function using HDL		CO2: Able to acquire knowledge about realization of digital circuits using CMOS
	Introducing of short-time processing of speech signals and time-frequency analysis of speech signals		CO3: Able to design Digital gates using HDL
	Introducing of the fundamentals of ML techniques useful for speech processing applications		CO4: Able to design of Complex circuits using HDL
			CO5: Able to perform analysis of speech signals using time-frequency representation.
			CO6: Able to develop ML techniques for speech recognition, signal and source separation.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	-	**1**	-	-	-	-	**2**	-	-	-	**3**	-	**3**
2	CO2	**3**	**3**	-	**1**	-	-	-	-	**2**	-	-	-	**2**	-	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	-	**2**	**2**	**3**	-	**2**	-	-	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	-	**2**	**2**	**3**	-	**2**	-	-	**1**	**3**	**3**	**3**
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
1	Analysis of speech signals using time-frequency representation	**02**	**CO1** **CO2** **CO3** **CO4** **CO5**
2	Algorithms for acoustic signal processing	**02**	
3	Feature extraction for source separation	**02**	
4	Speech enhancement	**02**	
5	Speaker emotion recognition	**02**	
6	Introduction of HDL Software Tool.	**02**	
7	Implementation and Simulation of Logic Gate with HDL.	**02**	
8	Implementation of Digital Logic with Different Model of HDL.	**02**	
9	Design and Implementation of Arithmetic Building Blocks in FPGA.	**02**	
10	Design and Implementation of Array Building Blocks in FPGA.	**02**	
	Total Hours	**20**	

Essential Readings

1. M. Sarrafzadeh and C. K. Wong, "An Introduction to VLSI Physical Design", McGraw Hill, 1st Edition, 1996
2. P. Ashenden, "Digital Design using VHDL", Elsevier, 1st Edition, 2007
3. J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, "Discrete-Time Processing of Speech Signals", WileyIEEE Press, NY, USA.
4. C.M. Bishop, "Pattern Recognition and Machine Learning", 2nd Edition, Springer, 2011.

Supplementary Readings

1. P.J Anderson, "The designer's guide to VHDL", Morgan Kaufman, 1st Edition, 2008
2. N.H.E. Weste, K. Haase, D. Harris, A. Banerjee, "CMOS VLSI Design: A circuits and Systems Perspective", Pearson Education, 4th Edition, 2011
3. W.Wolf , "FPGA System design", Pearson, 1st Edition, 2004
4. D. Yu and L. Deng, "Automatic Speech Recognition: A Deep Learning Approach", Springer, 2016

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Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 473	**Fundamentals of Image and video Processing**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To study the fundamentals of digital image processing.		CO1	Ability to understand the fundamentals of digital image processing.
	To study the various enhancement and segmentation techniques used in image processing.		CO2	Ability to analyse the various enhancement and segmentation techniques used in image processing.
	To study the basic steps of video processing.		CO3	Ability to understand the basic steps of video processing.
	To study the different two dimensional motion estimation methods.		CO4	Ability to analyse the different two dimensional motion estimation methods

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**	**-**
2	CO2	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**-**
3	CO3	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**-**
4	CO4	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**	**-**

SYLLABUS

No.	Content	Hours	COs
I	Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system, Sampling and Quantization of an Image, Basic relationship between Pixels, Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms.	**5**	**CO1**
II	Image Processing Techniques: Image Enhancement in Spatial Domain methods and Frequency Domain methods, Segmentation concepts, Point, Line and Edge detection, Thresholding, region based segmentation.	**8**	**CO2**
III	Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation, Photometric Image formation, Sampling of Video Signals, Filtering operations.	**6**	**CO3**
IV	2-D Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation.	**7**	**CO4**
	Total Hours	**26**	

Essential Readings

1. Gonzalez R. C. and Woods R. E, "Digital Image Processing", Pearson Prentice Hall, 2nd edition, 2002.
2. Yaowang, JoemOstarmann and Ya–quinZhang, "Videoprocessing and communication", Prentice Hall International, 1st edition, 2001.

Supplementary Readings

1. Gonzalez R. C, Woods R. E and Eddins S. L "Digital Image Processing using MATLAB", McGraw Hill Education, 2nd edition, 2017.
2. M. Tekalp,"Digital video Processing", Prentice Hall International, 2nd edition, 2015.

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Department	**Electronics and Communication Engineering**	Semester	**VII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 475	**Basics of VLSI**	**2**	**0**	**0**	**2**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
Preliminaries on MOS device		CO1	Able to understand basics of MOS.
Fundamentals of Digital Circuits.		CO2	Able to learn basic Digital circuits.
Basic analysis of CMOS inverter		CO3	Able to design CMOS inverter.
CMOS combinational circuit design		CO4	Able to design CMOS combinational circuits.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	-	**1**	-	-	-	-	**2**	-	-	-	**3**	-	**3**
2	CO2	**3**	**3**	-	**1**	-	-	-	-	**2**	-	-	-	**2**	-	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	-	-	-	-	-	-	-	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	-	**2**	**2**	**3**	-	**2**	-	-	**1**	**2**	**3**	**2**
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**INTRODUCTION TO MOS DEVICE:** First Glance at the MOS device MOS Transistor under static conditions, threshold voltage, channel length modulation.	**4**	**CO1**
II	**DIGITAL LOGIC DESIGN** Logic Gates, Boolean functions, AOI logic, Full adder design, Decoder, Multiplexer.	**8**	**CO2**
III	**INVERTER DESIGN:** Static CMOS inverter, performance of CMOS inverter, propagation delay sizing inverter for performance.	**04**	**CO2, CO3**
IV	**CMOS COMBINATIONAL LOGIC DESIGN:** Static CMOS designs, complementary CMOS design, power consumption in CMOS logic gates, design techniques to reduce switching activity, pass transistor logic, differential pass transistor logic, dynamic CMOS design, Domino CMOS logic, NPCMOS-logic style.	**8**	**CO3, CO4**
Total Hours		**24**	

Essential Readings

1. R. Jan, Chandrakasan, and A. Nikolic, Digital Integrated Circuits: A Design Perspective , Pearson Education 2nd edition 2016.

Supplementary Readings

1. S-M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis And Design, Tata McGraw-Hill, 3 rd edition 2002.

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Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 410	**INTRODUCTION TO MEMS**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Familiarization to the fundamentals and applications of MEMS	Course Outcomes	CO1	Ability to understand the basic operation of MEMS devices and their applications
	Understand the basic principles and operation of MEMS devices		CO2	Able to design MEMS devices based on various transduction techniques
	Understand various materials fabrication technologies used in MEMS		CO3	Able to identify materials and fabrication processes to develop MEMS devices

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	**1**	-	-
2	CO2	**2**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	**1**	-	-
3	CO3	**2**	**2**	-	-	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-

SYLLABUS

No.	Content	Hours	COs
I	Overview of MEMS: Introduction to MEMS, Typical MEMS devices and products, Evolution of Microfabrication, Microelectronics and MEMS, Applications of MEMS.	**4**	**CO1**
II	Working Principles of MEMS devices: Introduction to MEMS based sensors ans actuators, Basic Mechanical Structures used in MEMS (Diaphagms, Cantilever, Bridge structures), Various Transduction Mechanisms for MEMS devices (Piezoresistive, Piezoelectric, Capacitive, Electrostatic transduction mechanisms), Basic electronic circuitry for interfacing of MEMS devices.	**12**	**CO2**
III	Materials and Fabrication Processes for MEMS: Materials - Silicon as a Substrate Material, Silicon Compounds, Gallium Arsenide, Quartz, Piezoelectric Crystals, Polymers, Packaging Materials, Fabrication processes: Photolithography, Diffusion, Ion Implantation, Oxidation, Chemical Vapor Deposition, Physical Vapor Deposition – Sputtering, Deposition by Epitaxy, Dry and Wet Etching Techniques, Micromachining processes: Bulk and Surface Micromachining, The LIGA Process.	**12**	**CO3**
IV	Study of various and recently developed MEMS based devices for various applications.	**8**	**CO1, CO2, CO3**
	Total Hours	**36**	

Essential Readings

1. T.R. Hsu, “MEMS and Microsystems: Design and Manufacture”, McGraw Hill, 1st Edition, 2002.
2. M.H. Bao, “Analysis and Design Principles of MEMS Devices”, Elsevier, 1st Edition, 2008.
3. M.J. Madou, “Fundamentals of Microfabrication: The Science of Miniaturization”, CRC Press, 2nd Edition, 2002.

Supplementary Readings

1. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Aatre, “Micro and Smart Systems”, Wiley India, 1st Edition, 2010.
2. S.D. Senturia, “Microsystem Design”, Springer, 1st Edition, 2001.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 412	**Wideband Communication**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes	
To provide complementary knowledge to wireless communication.	CO1	Able to acquire the knowledge about direct sequence spread spectrum technology.
To introduce the standard and technology behind 3G, 4G and 5G networks.	CO2	Able to understand the DSSS based CDMA wireless system.
To enhance knowledge of wireless technology and current standards.	CO3	Able to analyse the multicarrier system for wireless communication.
	CO4	Able to examine MIMO systems and different diversity techniques in multi antenna scenarios.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**	**3**
2	CO2	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**	**3**
3	CO3	**2**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**
4	CO4	**3**	**2**	**2**	**1**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Spread Spectrum:** Spread-Spectrum Principles, Direct-Sequence Spread Spectrum (DSSS), DSSS System Model, Spreading Codes for ISI Rejection: Random, Pseudorandom, and *m*-Sequences , Synchronization , RAKE Receivers , Frequency-Hopping Spread Spectrum (FHSS) , Multiuser DSSS Systems, Spreading Codes for Multiuser DSSS, Downlink Channels, Uplink Channels, Multiuser Detection.	**08**	**CO1**
II	**CDMA System:** General Principles of CDMA, CDMA Codes and Their Properties, CDMATransmission Channel Model, Receiver Structures for Synchronous Transmission, Receiver Structures for MC-CDMA and Asynchronous Wideband CDMA Transmission, Examples for CDMA Systems: Wireless LANs according to IEEE 802.11, Global Positioning System etc.	**08**	**CO1** **CO2**
III	**Overview of Multicarrier Communication:** General Principles: The Concept Of Multicarrier Transmission, Multicarrier Modulation with Overlapping Subchannels, Discrete Implementation of Multicarrier Modulation, The DFT and Its Properties, The Cyclic Prefix, Orthogonal Frequency-Division Multiplexing (OFDM), Matrix Representation of OFDM, Vector Coding, **Challenges in Multicarrier Systems**: Peak-to-Average Power Ratio, Frequency and Timing Offset. Case Study: The IEEE 802.11a Wireless LAN Standard. Other types of MC techniques	**11**	**CO3**
IV	**MIMO System:** Useful Matrix Theory, Deterministic MIMO Channel Capacity, Channel Capacity when CSI is Known to the Transmitter Side, Channel Capacity when CSI is Not Available at the Transmitter Side, Channel Capacity of SIMO and MISO Channels, Channel Capacity of Random MIMO Channels, Antenna Diversity, pace-Time Coding (STC), Space-Time Block Code (STBC)	**09**	**CO4**
	Total Hours	**36**	

Essential Readings

1. Goldsmith, Andrea. *Wireless communications*. Cambridge university press, 2005.,
2. Molisch Andreas,"Wideband Wireless Digital Communication",Pearson LPE,1st Ed., 2001.

Supplementary Readings

1. Cho, Yong Soo, Jaekwon Kim, Won Y. Yang, and Chung G. Kang. *MIMO-OFDM wireless communications with MATLAB*. John Wiley & Sons, 2010.
2. Schulze, Henrik, and Christian Lüders. *Theory and applications of OFDM and CDMA: Wideband wireless communications*. John Wiley & Sons, 2005.
3. Fazel, Khaled, and Stefan Kaiser. *Multi-carrier and spread spectrum systems: from OFDM and MC-CDMA to LTE and WiMAX*. John Wiley & Sons, 2008.

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Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 414	**Radar Engineering**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To understand the fundamentals of radar and its parameters		CO1	Able to acquire the knowledge about fundamentals radar and its parameters
	To familiarize with the concepts of different radar types		CO2	Able to familiarize with the basic concepts of different radar types
	To introduce idea of radar signals & clutter		CO3	Able to understand basics of radar signals & clutter
	To comprehend various types of devices and radar systems		CO4	Able to analyse various devices and radar systems

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
2	CO2	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
3	CO3	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
4	CO4	**3**	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	**3**	**2**	**2**	-
5	CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SYLLABUS

No.	Content	Hours	COs
I	**Introduction:** Historical background, radar terminology, radar band designations, Radar block diagram, and radar equation: detection of signals in noise and signal-to-noise ratio, Probabilities of detection & False alarm, integration of radar pulses, radar cross section, distributed targets, Transmitted power, pulse-repetition frequency, antenna parameters & system losses, introduction to radar clutter.	**09**	**CO1, CO2**
II	**Radar types:** Pulse radars and CW radars, Advantages of coherent radar, Doppler radar and MTI: Doppler effect, delay-line cancellers, blind speeds, staggered PRFs, Digital filter bank, Moving Target Detector, limitations of MTI, tracking with radar, mono pulse tracking, conical scan, limitation to tracking accuracy	**9**	**CO1, CO2**
III	**Radar signals & clutter:** Basic radar measurement, theoretical accuracy of radar measurements, Range and velocity ambiguities, the ambiguity diagram, pulse compression-principles, the matched filter, chirp waveforms, Waveform design: nonlinear FM, phase codes, waveform generation and compression. Descriptions of land & sea clutter, statistical models for surface clutter, detection of targets in clutter.	**9**	**CO3**
IV	**Devices and radar systems:** Radar transmitter: Solid-state RF power source, Magnetron, other RF power sources, Radar receiver: Super heterodyne receiver, receiver noise figure, duplexers & diplexers, Receiver protectors, Applications: Electronic Warfare: ESM, ECM, ECCM; super resolution, IFM, types of jammers, Stealth and counter-stealth: stealth techniques for aircraft and other target types, low frequency and UWB radar, System design examples	**8**	**CO4**
Total Hours		**36**	

Essential Readings

1. M. I. Skolnik, “Introduction to Radar Systems ", Tata- MacGraw Hill, 3rd Edition, 2001.
2. M. H. Carpentier, “Principles of Modern Radar”, Artech House, 3rd Edition, 2010.

Supplementary Readings

1. C M. I. Richards, “Fundamentals of Radar Signal Processing”, McGraw-Hill, 2nd Edition, 2005.
2. D.K. Barton, H. R. Ward, “Handbook of Radar Measurement”, Artech House, 1st Edition, 1984.

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Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 416	**Digital Arithmetic Circuits**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To study digital representation of Various number systems		CO1	Able to understand different representation of number systems
	To understand the redundant and residue number system and application		CO2	Able to apply the concept of redundant number and residue number system and implementation concept
	To introduce the concept of binary addition, multiplication and division circuits		CO3	Criticize the of different adder architectures
	To develop the concept of floating point arithmetic		CO4	Criticize the different architectures of multipliers and dividers
	To analyse the concept of floating point arithmetic circuits		CO5	Able to understand the floating point number representation in digital domain and architectures of floating point circuits
			CO6	

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**2**	-	-	**1**	**1**	**3**	-	-	-	-	-	-	**3**	-	**3**
2	CO2	-	-	-	**3**	**2**	**3**	-	-	-	-	-	-	-	**2**	**2**
3	CO3	-	-	**3**	**2**	**2**	**3**	-	-	-	-	-	-	-	**3**	**2**
4	CO4	-	-	-	-	-	-	**3**	**3**	-	-	-	-	**2**	**3**	**2**
5	CO5	-	-	-	-	-	-	-	**3**	**2**	-	-	-	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**Review of the Number Representation** Numbers and their encodings, Fixed-radix positional number systems, Number radix conversion, Classes of number representations, Signed-magnitude representation, Biased representations, Complement representations, Direct and indirect signed arithmetic.	**06**	**CO1**
II	**Redundant Number Systems** Coping with the carry problem, Redundancy in computer arithmetic, Digit sets and digit-set conversions, Generalized signed-digit numbers, Carry-free addition algorithms, Conversions and support functions. Introduction to Residue Number systems.	**04**	**CO2**
III	**Addition / Subtraction** Bit-serial and ripple-carry adders, Conditions and exceptions, Analysis of carry propagation, Carry completion detection, Manchester carry chains adders. Carry-look-ahead adder design, Ling adder and related designs, Carry determination as prefix computation, Alternative parallel prefix networks, VLSI implementation aspects , Modular two-operand adders	**06**	**CO3, CO4**
IV	**Multiplication** Shift/add multiplication algorithms, Programmed multiplication, Basic hardware multipliers, Multiplication of signed numbers, Multiplication by constants, and Preview of fast multipliers. Radix-4 multiplication, Modified Booth's recoding, Radix-8 and radix-16 multipliers, Multi-bit multipliers, VLSI complexity issues. Full-tree multipliers, Alternative reduction trees, Tree multipliers for signed numbers, Partial-tree and truncated multipliers, Array multipliers, Pipelined tree and array multipliers.	**08**	**CO4, CO5**
V	**Division** Shift/subtract division algorithms, Programmed division, Restoring hardware dividers, Nonrestoring and signed division, Division by constants, Radix-2 SRT division. Basics of high-radix division, Using carry-save adders, Radix-4 SRT division, General high-radix dividers, Quotientdigit selection, Using p-d plots in practice.	**08**	**CO3, CO4, CO5**
VI	**Floating Point Arithmetic** Floating-Point Representations, Floating-point numbers, The ANSI/IEEE floating-point standard, Basic floating-point algorithms, Conversions and exceptions, Rounding schemes, Logarithmic number systems. Floating-point adders/subtractors, Pre- and post-shifting, Rounding and exceptions, Floating-point multipliers and dividers, Fused-multiply-add units, Logarithmic arithmetic unit.	**08**	**CO4, CO5**
	Total Hours	**40**	

Essential Readings

1. B. Parhami, “Computer Arithmetic: Algorithms and Hardware Designs”, Oxford University Press, 2nd Edition, 2010
2. I. Koren, Computer Arithmetic Algorithms, Prentice Hall Publications, 2nd Edition, 2003

Supplementary Readings

1. M. D. Ercegovac, Digital Arithmetic, The Morgan Kaufmann Series in Computer Architecture and Design. 1st Edition, 2003.
2. D. A. Patterson and J. L. Hennessy, Computer Organization and Design, Morgan Kaufmann Publishers Inc. San Francisco, 5 th Edition, 2014.

	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 418	**Pattern Recognition and Applications**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	To study the fundamentals of pattern recognition.		CO1	Ability to understand the fundamentals of pattern recognition.
	To study the various parameter based estimation methods.		CO2	Ability to analyse the various parameter based estimation methods.
	To study some dimensionality reduction methods.		CO3	Ability to analyse some dimensionality reduction methods.
	To study the fundamentals of artificial neural networks.		CO4	Ability to understand the fundamentals of artificial neural networks.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**	**-**
2	CO2	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**-**
3	CO3	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**-**
4	CO4	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**1**	**-**

SYLLABUS

No.	Content	Hours	COs
I	Introduction: Introduction to statistical pattern recognition, Bayes Decision Theory: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Discrete features.	**10**	**CO1**
II	Parameter Estimation Methods: Maximum-Likelihood estimation, Bayesian estimation, Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs.	**9**	**CO2**
III	Dimensionality reduction: Principal component analysis - it relationship to eigen analysis. Fisher discriminant analysis - Generalised eigen analysis.	**8**	**CO3**
IV	Artificial neural networks: Multilayer perceptron - feedforward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks.	**8**	**CO4**
	Total Hours	**35**	

Essential Readings

1. R. O. Duda, P. E. Hart and D. G. Stork, "Pattern classification", John Wiley & Sons, 2nd edition, 2002.
2. C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1st edition, 1995.

Supplementary Readings

1. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 1st edition, 2006.

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Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 420	**Advanced Semiconductor for RF and Power Application**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	Advanced Compound Semiconductor (Especially III-V) basics		CO1	Able to understand basics of advanced compound semiconductor.
	Power and RF device basics		CO2	Able to learn basic of new device design.
	Basics of III-V device (Especially HEMT & HBT)		CO3	Able to apply knowledge on Power and RF circuit.
	III-V device (Especially HEMT & HBT) based circuit		CO4	Able to estimate device level optimization.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**
2	CO2	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Compound Semiconductor Basics:** Difference between Silicon and the compound semiconductor, Growth of epitaxial crystal, Interfaces, Hetero junction interface and Homo junction interface, Bandgap engineering, defects, trap, dislocation. Impact of lattice constant versus bandgap. Properties of Compound Semiconductor.	**12**	**CO1**
II	**High electron mobility transistor (HEMT):** Design of the HEMT device. Properties of HEMT. Design specs of RF HEMT and characteristics of the RF HEMT. Thermal management of the HEMT. Design specs of Power HEMT and characteristics of the Power HEMT.	**6**	**CO2**
III	**Hetero-junction bipolar design (HBT)** Difference between BJT and HBT. Design specs and characteristics of the HBT for power and RF device. Thermal management of the HBT. Optimization techniques for achieving the trade-off between the properties.	**6**	**CO2**
IV	**Design of Compound Semiconductor based RF circuit** Design of GaN based Power Amplifier, Low noise amplifier, Difference between monolithic microwave integrated circuit (MMIC) and radio-frequency integrated circuit (RFIC)	**6**	**CO3, CO4**
V	**Design of Compound Semiconductor based Power circuit** Design of GaN based DC-DC converter (especially buck and boost converter design). Difference between the properties of the silicon based buck and boost converter and GaN based buck and boost converter	**6**	**CO3, CO4**
	Total Hours	**36**	

Essential Readings

1. Hadis Morkoç, Handbook of Nitride Semiconductors and Devices: Materials Properties, Physics and Growth, Volume 1, John Wiley and Sons, 1st Edition, 2008.
2. Cheng, Keh Yung, III–V Compound Semiconductors and Devices, Springer Publications, 1st Edition, 2020.
3. Alex Lidow, M. de Rooij, J. Strydom, D. Reusch, and J. Glaser, GaN Transistors for Efficient Power Conversion, John Wiley and Sons, 3rd Edition, 2019.

Supplementary Readings

1. Fay, Patrick, Jena, Debdeep, Maki, Paul, High-Frequency GaN Electronic Devices, Springer Publications, 1st Edition, 2020.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 422	**Low power VLSI**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives		Course Outcomes		
	Preliminaries on Power dissipation		CO1	Able to understand basics of Power Dissipation.
	Fundamentals of low power circuits.		CO2	Able to learn low power circuit design.
	Basic synthesis for low power circuits.		CO3	Able to learn circuit level optimization.
	Basics of SRAM memory		CO4	Able to acquire knowledge on SRAM.
	Basics of design and test of low voltage circuits		CO5	Able to design low power circuit at submicron level.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**
2	CO2	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**
3	CO3	**2**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**
4	CO4	**2**	**2**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**
5	CO5	**2**	**2**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**3**	**3**	**3**

SYLLABUS

No.	Content	Hours	COs
I	**POWER DISSIPATION IN CMOS** Sources of power dissipation – Physics of power dissipation in MOSFET devices: The MIS structure, long channel MOSFET, Submicron MOSFET , gate induced drain leakage– Power dissipation in CMOS : short circuit dissipation, dynamic dissipation, load capacitance– Low power VLSI design: Limits – principles of low power design.	**8**	**CO1**
II	**DESIGN OF LOW POWER CIRCUITS:** Transistor and Gate Sizing : Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction - Network Restructuring and Reorganization : Transistor Network Restructuring, Transistor Network Partitioning and Reorganization - Special Latches and Flip-flops : Self-gating Flip-flop, Varieties of Boolean Functions, Adjustable Device Threshold Voltage.	**10**	**CO2**
III	**SYNTHESIS FOR LOW POWER** Behavioral Level Transforms, Logic Level Optimization for Low power, Circuit Level Optimization	**04**	**CO2, CO3**
IV	**LOW POWER STATIC RAM ARCHITECTURES** Organization of a static RAM, MOS Static RAM Memory cell, Banked organization of SRAMs, Reducing voltage swings on bit lines, Reducing power in write driver circuits, Reducing power in sense amplifier circuits, method for achieving low core voltages from a single supply.	**8**	**CO3, CO4**
V	**DESIGN AND TEST OF LOW VOLTAGE CMOS CIRCUITS** Circuit Design style, Leakage current in deep submicrometer transistors, Deep submicrometer device design issues, Low voltage circuit design techniques, Designing deep submicrometer ics with elevated intrinsic leakage, multiple supply voltages.	**6**	**CO4, CO5**
	Total Hours	**36**	

Essential Readings

1. K. Roy and S. C. Prasad, Low Power CMOS VLSI Circuit Design, John Wiley and Sons, 3 rd Edition, 2009.
2. Jan Rabaey, Low Power Design Essentials, Springer Publications, 1 st Edition, 2009.

Supplementary Readings

1. Chandrakasan and R. Brodersen, Low-Power CMOS Design, IEEE Press, 1 st Edition, 1995.
2. Chandrakasan, Bowhill, and Fox, Design of High-Performance Microprocessors, IEEE Press, 1 st Edition, 2000.

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Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 424	**Internet of Things**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
Familiarization to the fundamentals IOT applications		CO1	Comprehend the essentials of IoT and its applications
Design IOT systems with energy efficient computing platform sensors and cloud platform		CO2	Understand the concepts of IoT Architecture Reference model and IoT reference architecture
Understand various layer protocols and its usage		CO3	Apply IP based protocols and Authentication Protocols for IoT
		CO 4	Analyze various IoT Application layer Protocols.
		CO 5	Design IoT-based systems for real-world problems.

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**2**	-	-	-	**2**	-	-	-	-	-	-	**2**	**1**	-	-
2	CO2	**2**	**3**	**2**	**2**	-	**1**	-	-	-	-	-	-	**2**	**1**	-	-
3	CO3	**2**	**3**	**2**	**3**	-	**1**	-	-	-	-	-	**2**	**2**	**1**	-	-
4	CO4	**2**	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**2**	**1**	-	-
5	CO5	-	-	-	**2**	-	**2**	**3**	-	-	-	-	-	-	**1**	**2**	**1**

SYLLABUS

No.	Content	Hours	COs
I	Introduction to IoT, Sensing, Actuation, Basics of Networking Wifi , Bluetooth, Zigbee Communication Protocols , Sensor Networks.	**12**	**CO1**
II	Sensor Networks, Machine-to-Machine Communications. Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino and Rasberry Phi .	**12**	**CO2**
III	Introduction to Python programming, Introduction to Raspberry. Implementation of IoT with Raspberry Pi, Introduction to SDN. SDN for IoT, Data Handling and Analytics, Cloud Computing.	**8**	**CO3**
IV	Cloud Computing, Sensor-Cloud. Fog Computing, Smart Cities and Smart Homes Connected Vehicles, Smart Grid, Industrial IoT. Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring.	**8**	**CO1, CO2, CO3**
Total Hours		**36**	

Essential Readings

1. Pethuru Raj and Anupama C. Raman "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", Ist edition CRC Press, 2017
2. Arshdeep Bahga and Vijay Madisetti "Internet of Things: A Hands-on Approach", Ist edition Orient Blackswan Private Limited , 2015
3. Hersent, Olivier, David Boswarthick, and Omar Elloumi. The internet of things: Key applications and protocols. John Wiley & Sons, 2011.
4. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.

Supplementary Readings

1. Bassi, Alessandro, et al, "Enabling things to talk", Springer-Verlag Berlin An, 2016.

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Programme	**Bachelor of Technology in Electronics and Communication Engineering**	Year of Regulation	**2018-19**
Department	**Electronics and Communication Engineering**	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 426	**Fiber Optics Communication**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To develop the student's ability to analyze the different kind of losses, signal distortion in fiber optical communication and other signal degradation factors		CO1	Able to identify, formulate, and solve engineering problems in the area fiber optics communication
To familiarize students with the fiber optical source materials, LED structures and Laser diodes		CO2	Able to understand basic terminology, concepts and take the lead in fiber optic discussions and what are its requirements
To familiarize students with the fiber optical receivers such as PIN photodiode and APD diodes, noise performance in photo detector receiver operation and configuration		CO3	Able to analyse the operation of LEDs, laser diodes and PIN photo-detectors (spectral properties, bandwidth and circuits) and apply in optical systems
To familiarize students with operational principles of WDM and measurement analysis		CO4	Able to measure the amount of light lost going through an optical system and different optical amplifiers

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**2**	**2**	**-**
2	CO2	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**2**	**-**
3	CO3	**1**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**3**	**2**	**-**
4	CO4	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**3**	**-**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction** Elements of fiber optic communication; Nature of light, Basic optical laws; Fiber types; Fiber fabrication	**07**	**CO1**
II	**Signal Degradation In Optical Fibers** Attenuation, Absorption losses, scattering losses, bending losses, Signal dispersion in fibers, non-linear effects in fiber	**05**	**CO1, CO2**
III	**Optical Sources** Laser diode, principle and operation of light emitting diode, Comparison Between LED and LD	**05**	**CO2, CO3**
IV	**Photo Detectors and Receiver System** PIN diode, Avalanche photodiode, fundamental receiver operation; System performance evaluation criteria, Eye Diagram, BER, OSNR, and Q-Factor	**06**	**CO2, CO3**
V	**Power Launching & Coupling, Digital Links** Source to fiber power launching, lensing schemes for coupling improvement, fiber slicing; fiber to fiber joints; The concept of digital link, point to point link, Power penalties	**07**	**CO4**
VI	**WDM Concepts and Components** Principles of WDM, WDM System Configuration, Types of WDM System, WDM Components, Applications of WDM Systems.	**04**	**CO1, CO4**
VII	**Optical amplifiers and measurements** Principle of Optical Amplification, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Semiconductor Optical Amplifiers, Refractive Index Measurements, Attenuation Measurement, Dispersion Measurement, OTDR Field Applications	**05**	**CO4**
	Total Hours	**39**	

Essential Readings

1. Gerd Kaiser, "Optical Fiber Communication", McGraw Hill, 5th edition, 2013.
2. *Senior J. M., "Optical Fiber Communication - Principle And Practice", PHI, 2nd Ed., 15th Indian Reprint, 2003.*

Supplementary Readings

1. Agrawal G.P., "Fiber Optic Communication Systems", John Wiley & Sons, 4th Ed., 2010.
2. Mynbave and Scheiner, "Fiber Optics Communications Technology", Pearson Education, 1ST Indian Ed., 2001.
3. Ramaswami Rajiv and Sivarajan K. N., "Optical Networks A Practical Perspective", Elsevier, Morgan Kaufmann Publishers, 3rd Ed:, 2009.

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Department	Electronics and Communication Engineering	Semester	**VIII**

Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 428	Statistical Signal Analysis	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
This course introduces of concepts of statistical signal analysis		CO1	Able to explain basic constituents of a random variables
This course introduces of stochastic processes and systems in signal analysis		CO2	Able to apply probability concepts in analysis of signals
This course introduces of Wiener filtering and Kalman filtering in signal analysis		CO3	Able to apply probability concepts in designing of systems.
		CO4	Able to apply Wiener filtering and Kalman filtering in signal estimation and signal analysis

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**1**	-	-	**1**	-	-	-	-	-	-	-	**2**	-	**1**	-
2	CO2	**1**	**2**	**2**	**2**	-	-	-	-	-	-	-	**1**	**2**	-	**2**	-
3	CO3	-	**2**	**2**	**1**	**2**	-	-	-	-	-	-	**2**	**2**	**2**	**2**	-
4	CO4	-	**2**	-	**1**	**2**	-	-	-	-	-	-	**2**	**2**	**2**	**2**	-

SYLLABUS

No.	Content	Hours	Cos
I	Review of probability theory and random variables: Transformation (function) of random variables, Conditional expectation; Sequences of random variables: convergence of sequences of random variables	**06**	**CO1**
II	Stochastic processes: wide sense stationary processes, orthogonal increment processes, Wiener process, and the Poisson process, KL expansion.; Ergodicity, Mean square continuity, mean square derivative and mean square integral of stochastic processes	**12**	**CO2**
III	Stochastic systems: response of linear dynamic systems (e.g. state space or ARMA systems) to stochastic inputs, Lyapunov equations, correlational function, power spectral density function	**10**	**CO3**
IV	Introduction to linear least square estimation, Wiener filtering and Kalman filtering.	**08**	**CO4**
	Total Hours	**36**	

Essential Readings

1. Papoulis, “Probability, Random Variables And Stochastic Processes”, McGraw-Hill,4th Edition, 10th Reprint, 2006
2. William A. Gardner, "Introduction to Random Processes: with application to signals and systems", McGraw-Hill, 2nd Edition, 1989.
3. Larson H. J. and Shubert B. O., “Probabilistic Models In Engineering Science – Vol I, Random Variable and Stochastic Process, Vol II Random Noise Signals and Dynamic Systems”, Wiley Publication,1st Edition,1982.

Supplementary Readings

1. Hayes Monson H.,“Statistical Digital Signal Processing”, John Wiley,1st Edition,1996.
2. Montgomeri and Ruger,“Applied Statistics And Probability For Engineers”,John Wiley, 1st Edition,2006.
3. S. M. Kay, “Fundamentals of Statistical Signal Processing”, Prentice Hall, 1st Edition, Volume 1, 1993.

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Course Code	Course Name	Credit Structure				Marks Distribution			
		L	T	P	C	INT	MID	END	Total
EC 440	**Information Theory and Coding**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	Course Outcomes		
To enhance knowledge of probabilities, entropy, and measures of information.		CO1	Able to **understand** the basic notions of information and entropy
To introduce information theory, the fundamentals of error control coding techniques and their applications		CO2	Able to **analyse** the fundamental limits on performance of communication systems channels.
To develop noise immune information system		CO3	Able to **evaluate** a suitable lossy data compression technique for a given situation in communication systems
		CO4	Able to **analyse** the performance of error control codes, convolutional and block codes

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	CO1	**2**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**	**3**	**2**
2	CO2	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**	**3**
3	CO3	**2**	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**2**	**1**
4	CO4	**2**	**3**	**3**	**-**	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**1**	**2**	**3**	**2**	**2**

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Information and Entropy:** Information preview, Entropy of a source, Properties of entropy, Joint and conditional entropies, Mutual information, Relationship between entropy and mutual Information, Chain rules for entropy, Jensen's inequality and its consequences, Log sum inequality and its applications, Data processing inequality, Sufficient statistics, Fano's inequality.	**08**	**CO1**
II	**Information Channels** Information Channels, BSC and BEC Channels, Noiseless and Deterministic Channels, Cascaded Channels, Additivity of Mutual Information, Channel Capacity: Maximum Mutual Information (BSC and BEC), Channel Capacity of Weakly Symmetric Channels, Continuous Channels and Gaussian Channels, Information Capacity Theorem.	**08**	**CO1, CO2**
III	**Source Coding and Data Compression:** Instantaneous Codes, Examples of codes, Kraft inequality, Shannon's Noiseless Coding Theorem, Optimal codes, Bounds on the optimal code length, Huffman codes, Optimality of Huffman codes, Some comments on Huffman codes, Optimality of Huffman codes, Shannon–Fano–Elias coding, Competitive optimality of the Shannon code. Generation of discrete distributions from fair coins. Basic Concepts of Data Compression, Block-sorting Compression, Dictionary Coding, Statistical Compression, Prediction by Partial Matching, Image Coding.	**10**	**CO3**
IV	**Error-Correcting Codes:** Hamming Distance, Rings and Fields, Linear Spaces, Linear Spaces over the Binary Fields, Linear Codes, Encoding and Decoding, Codes Derived from Hadamard Matrices, Cyclic Codes: The Golay Code, Hamming Codes, Cyclic Redundancy Check Codes, Reed-Muller Codes, Burst-Correcting Codes: Bursts of Errors, Bose-Chaudhuri-Hocquenghem Codes, Reed-Solomon Codes. Convolutional Codes: Binary Convolutional Code, The Viterbi Algorithm, Trellis Modulation, Turbo Codes, Case study.	**10**	**CO4**
	Total Hours	**36**	

Essential Readings

1. M. Thomas et al., Elements of information theory. John Wiley & Sons, 2nd Edition, 2006.
2. R. Togneri et al, Fundamentals of information theory and coding design. CRC Press, 1st Ed., 2003.

Supplementary Readings

1. M. Borda. *Fundamentals in information theory and coding*. Springer Science & Business Media, 1st Ed., 2011.
2. M. Kelbert, et al., *Information theory and coding by example*. Cambridge University Press, 1st Ed., 2013.