CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

SEMESTERS III & IV

2020 SCHEME
(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)

MAR IVANIOS VIDYANAGAR, NALANCHIRA, THIRUVANANTHAPURAM – 695015, KERALA.

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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B. TECH DEGREE PROGRAMME

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM AND DETAILED SYLLABI (S3 – S4)

Items	Board of Studies (BoS)	Academic Council (AC)
Date of Approval	18.11.2020	30.12.2020
	04.02.2021	17.02.2021
	25.11.2021	22.04.2022
	11.08.2022	29.08.2022

Sd/-
Head of Department
Chairman, Board of Studies

Sd/-
Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Electronics and Communication Engineering Education and Research for the service of humanity.

Mission:

To provide quality Engineering Education and to carry out Research in the field of Electronics and Communication Engineering addressing the challenges faced by the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: The graduates of the Programme will have a successful career as Professionals in Industry or as Entrepreneurs, encompassing a broad spectrum of areas related to Electronics and Communication Engineering.

PEO2: They will be able to adapt to the changing needs of Industry and Academia through continuous learning and professional upgrading.

PEO3: They will exhibit social responsibility in their pursuit of technical excellence.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will have the ability to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **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.
4. **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.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **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.
7. **Environment and sustainability**: Understand the impact of the professional engineering solution sin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **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.
11. **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.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Design Electronic Circuits and Systems for Communication, Monitoring and Control Applications.

PSO2: Demonstrate the knowledge, in Electronics, Signal processing, Embedded Systems and Communication Engineering, required for providing technical solutions to real world problems

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B. Tech Programme in Electronics and Communication Engineering

For the students admitted from 2020-21

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of B. Tech Programme is placed in one of the nine categories as listed in table below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Total credits
1	Humanities and Social Sciences including Management Courses	HSC	8
2	Basic Science Courses	BSC	26
3	Engineering Science Courses	ESC	22
4	Programme Core Courses, Comprehensive Course Work and Viva Voce	PCC	76
5	Programme Elective Courses	PEC	15
6	Open Elective Courses	OEC	3
7	Project Work and Seminar	PWS	10
8	Mandatory Non-credit Courses (P/F) with Grade	MNC	---
9	Mandatory Student Activities (P/F)	MSA	2
	Total Mandatory Credits		**162**
	Value Added Courses (Optional) – Honours/Minor	VAC	20

ii) Semester-wise Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	***Total Credits***
Credits for Courses	*17*	*21*	*22*	*22*	*23*	*23*	*15*	*17*	***160***
Activity Points (Min.)	*40*				*60*				***100***
Credits for Activities	*2*								***2***
Total Credits									***162***
Value Added Courses (Optional) – Honours / Minor									***20***
Total Credits									***182***

SEMESTER I						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U10A	Linear Algebra and Calculus	3-1-0	4	4
B 1/2	BSC	PH0U10A	Engineering Physics A	3-1-0	4	4
		CY0U10A	Engineering Chemistry A	3-1-0	4	4
C 1/2	ESC	ES0U10A	Engineering Mechanics	2-1-0	3	3
		ES0U10B	Engineering Graphics	2-0-2	4	3
D 1/2	ESC	ES0U10C	Basics of Civil and Mechanical Engineering	4-0-0	4	4
		ES0U10D	Basics of Electrical and Electronics Engineering	4-0-0	4	4
E	HSC	HS0U10A	Life Skills	2-0-2	4	---
S 1/2	BSC	PH0U18A	Engineering Physics Lab	0-0-2	2	1
		CY0U18A	Engineering Chemistry Lab	0-0-2	2	1
T 1/2	ESC	ES0U18A	Civil and Mechanical Workshop	0-0-2	2	1
		ES0U18B	Electrical and Electronics Workshop	0-0-2	2	1
TOTAL					**23/24**	**17**

SEMESTER II						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U10B	Vector Calculus, Differential Equations and Transforms	3-1-0	4	4
B 1/2	BSC	PH0U10A	Engineering Physics A	3-1-0	4	4
		CY0U10A	Engineering Chemistry	3-1-0	4	4
C 1/2	ESC	ES0U10A	Engineering Mechanics	2-1-0	3	3
		ES0U10B	Engineering Graphics	2-0-2	4	3
D 1/2	ESC	ES0U10C	Basics of Civil and Mechanical Engineering	4-0-0	4	4
		ES0U10D	Basics of Electrical and Electronics Engineering	4-0-0	4	4
E	HSC	HS0U10B	Professional Communication	2-0-2	4	---
F	ESC	ES0U10E	Programming in **C**	2-1-2	5	4
S 1/2	BSC	PH0U18A	Engineering Physics Lab	0-0-2	2	1
		CY0U18A	Engineering Chemistry Lab	0-0-2	2	1
T 1/2	ESC	ES0U18A	Civil and Mechanical Workshop	0-0-2	2	1
		ES0U18B	Electrical and Electronics Workshop	0-0-2	2	1
TOTAL					**28/29**	**21**

SEMESTER III						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20A	Partial Differential Equations and Complex Analysis	3-1-0	4	4
B	PCC	EC1U20A	Solid State Devices	3-1-0	4	4
C	PCC	EC1U20B	Logic Circuit Design	3-1-0	4	4
D	PCC	EC1U20C	Network Theory	3-1-0	4	4
E 1/2	ESC	ES0U20A	Design & Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
F	MNC	NC0U20A	Sustainable Engineering	2-0-0	2	---
S	PCC	EC1U28A	Scientific Computing Lab	0-0-3	3	2
T	PCC	EC1U28B	Logic Design Lab	0-0-3	3	2
R/M	VAC		Remedial/Minor Course	3-1-0/ 4-0-0	4	4
TOTAL					**26/30**	**22/26**

SEMESTER IV						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20C	Probability, Random Processes and Numerical Methods	3-1-0	4	4
B	PCC	EC1U20D	Analog Circuits	3-1-0	4	4
C	PCC	EC1U20E	Signals and Systems	3-1-0	4	4
D	PCC	EC1U20F	Computer Architecture and Microcontrollers	3-1-0	4	4
E ½	ESC	ES0U20A	Design & Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
F	MNC	NC0U20B	Constitution of India	2-0-0	2	---
S	PCC	EC1U28C	Analog Circuits and Simulation Lab	0-0-3	3	2
T	PCC	EC1U28D	Microcontroller Lab	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0/ 4-0-0	4	4
TOTAL					**26/30**	**22/26**

SEMESTER V						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	EC1U30A	Linear Integrated Circuits	3-1-0	4	4
B	PCC	EC1U30B	Digital Signal Processing	3-1-0	4	4
C	PCC	EC1U30C	Analog and Digital Communication	3-1-0	4	4
D	PCC	EC1U30D	Control Systems	3-1-0	4	4
E ½	HSC	HS0U30A	Industrial Economics and Foreign Trade	3-0-0	3	3
		HS0U30B	Management for Engineers	3-0-0	3	3
F	MNC	NC0U30A	Disaster Management	2-0-0	2	--
S	PCC	EC1U38A	Analog Integrated Circuits and Simulation Lab	0-0-3	3	2
T	PCC	EC1U38B	Digital Signal Processing Lab	0-0-3	3	2
R/ M/ H	VAC		Remedial/Minor/Honours Course	3-1-0/ 4-0-0	4	4
			TOTAL		**27/31**	**23/27**

SEMESTER VI						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	EC1U30E	Electromagnetics	3-1-0	4	4
B	PCC	EC1U30F	VLSI Circuit Design	3-1-0	4	4
C	PCC	EC1U30G	Information Theory and Coding	3-1-0	4	4
D	PEC	EC1UXXX	Programme Elective I	2-1-0 /3-0-0	3	3
E 1/2	HSC	HS0U30A	Industrial Economics and Foreign Trade	3-0-0	3	3
		HS0U30B	Management for Engineers	3-0-0	3	3
F	PCC	EC1U30H	Comprehensive Course work	1-0-0	1	1
S	PCC	EC1U38C	Communication Lab	0-0-3	3	2
T	PWS	EC1U39A	Mini Project	0-0-3	3	2
R/ M/ H	VAC		Remedial/Minor/Honours Course	3-1-0/ 4-0-0	4	4
			TOTAL		**25/29**	**23/27**

PROGRAMME ELECTIVE I

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	EC1U31A	Digital System Design	2-1-0	3	3
		EC1U31B	Power Electronics	3-0-0	3	3
		EC1U31C	Data Analysis	2-1-0	3	3
		EC1U31D	Embedded System	3-0-0	3	3
		EC1U31E	Digital Image Processing	2-1-0	3	3
		EC1U31F	Introduction to MEMS	2-1-0	3	3
		EC1U31G	Quantum Computing	2-1-0	3	3

SEMESTER VII						
Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
A	PCC	EC1U40A	Microwaves and Antennas	2-1-0	3	3
B	PEC	EC1UXXX	Programme Elective II	2-1-0/ 3-0-0	3	3
C	OEC	EC0UXXX	Open Elective	2-1-0/ 3-0-0	3	3
D	MNC	NC0U40A	Industrial Safety Engineering	2-1-0	3	---
E	PCC	EC1U48A	Electromagnetics Lab	0-0-3	3	2
T	PWS	EC1U49A	Seminar	0-0-3	3	2
U	PWS	EC1U49B	Project Phase I	0-0-6	6	2
R/ M/ H	VAC		Remedial/Minor/Honours Course	0-1-6/ 4-0-0	7/4	4
TOTAL					**24/(31/28)**	**15/19**

PROGRAMME ELECTIVE II

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
B	PEC	EC1U41A	Optical Fiber Communication	3-0-0	3	3
		EC1U41B	Computer Networks	3-0-0	3	3
		EC1U41C	Opto Electronic Devices	2-1-0	3	3
		EC1U41D	Instrumentation	2-1-0	3	3
		EC1U41E	Error Control Codes	2-1-0	3	3
		EC1U41F	Machine Learning	2-1-0	3	3
		EC1U41G	DSP Architectures	2-1-0	3	3

OPEN ELECTIVE

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	OEC	EC0U41A	Mechatronics	2-1-0	3	3
		EC0U41B	Biomedical Instrumentation	3-0-0	3	3
		EC0U41C	Electronic Hardware for Engineers	3-0-0	3	3
		EC0U41D	IoT and Applications	2-1-0	3	3
		EC0U41E	Entertainment Electronics	2-1-0	3	3

SEMESTER VIII						
Slot	**Cate-gory Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	EC1U40B	Wireless Communication	3-0-0	3	3
B	PEC	EC1UXXX	Programme Elective III	3-0-0/ 2-1-0	3	3
C	PEC	EC1UXXX	Programme Elective IV	3-0-0/ 2-1-0	3	3
D	PEC	EC1UXXX	Programme Elective V	3-0-0/ 2-1-0	3	3
T	PCC	EC1U40C	Comprehensive Viva Voce	1-0-0	1	1
U	PWS	EC1U49C	Project Phase II	0-0-12	12	4
R/ M/ H	VAC		Remedial/Minor/Honours Course	0-1-6	7	4
			TOTAL		**25/32**	17/21

PROGRAMME ELECTIVE III

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
B	PEC	EC1U42A	Biomedical Engineering	3-0-0	3	3
		EC1U42B	Satellite Communication	3-0-0	3	3
		EC1U42C	Secure Communication	3-0-0	3	3
		EC1U42D	Pattern Recognition	3-0-0	3	3
		EC1U42E	RF Circuit Design	3-0-0	3	3
		EC1U42F	Mixed Signal Circuit Design	2-1-0	3	3
		EC1U42G	Entrepreneurship	3-0-0	3	3

PROGRAMME ELECTIVE IV

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	PEC	EC1U43A	Modern Communication Systems	3-0-0	3	3
		EC1U43B	Real Time Operating Systems	2-1-0	3	3
		EC1U43C	Adaptive Signal Processing	2-1-0	3	3
		EC1U43D	Microwave Devices and Circuits	3-0-0	3	3
		EC1U43E	Speech & Audio Processing	3-0-0	3	3
		EC1U43F	Analog CMOS Design	2-1-0	3	3
		EC1U43G	Robotics	3-0-0	3	3

PROGRAMME ELECTIVE V

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	EC1U44A	Mechatronics	3-0-0	3	3
		EC1U44B	Optimization Techniques	2-1-0	3	3
		EC1U44C	Computer Vision	2-1-0	3	3
		EC1U44D	Low Power VLSI	2-1-0	3	3
		EC1U44E	Internet of Things	2-1-0	3	3
		EC1U44F	Renewable Energy Systems	3-0-0	3	3
		EC1U44G	Organic Electronics	3-0-0	3	3

B. Tech (MINOR)

Semester	BASKET I				BASKET II				BASKET III			
	Course Number	**Course**	**L-T-P**	**Credit**	**Course Number**	**Course**	**L-T-P**	**Credit**	**Course Number**	**Course**	**L-T-P**	**Credit**
S3	EC0M 20A	Electronic Circuits	3-1-0	4	EC0M 20B	Analog Communi cation	4-0-0	4	EC0M 20C	Introductio n to Signals and Systems	3-1-0	4
S4	EC0M 20D	Microcont rollers	3-1-0	4	EC0M 20E	Digital Communi cation	3-1-0	4	EC0M 20F	Introductio n to Digital Signal Processing	3-1-0	4
S5	EC0M 30A	Embedded System Design	3-1-0	4	EC0M 30B	Communi cation Systems	4-0-0	4	EC0M 30C	Topics in Digital Image Processing	3-1-0	4
S6	EC0M 30D	VLSI Circuits	3-1-0	4	EC0M 30E	Data Networks	4-0-0	4	EC0M 30F	Topics in Computer Vision	3-1-0	4
S7	EC0M 49A	Mini Project	0-1-6	4	EC0M 49A	Mini Project	0-1-6	4	EC0M 49A	Mini Project	0-1-6	4
S8	EC0M 49B	Mini Project	0-1-6	4	EC0M 49B	Mini Project	0-1-6	4	EC0M 49B	Mini Project	0-1-6	4

B. Tech (HONOURS)

Semester	GROUP I				GROUP II				GROUP III			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S4	EC1H 20A	Nanoelectronics	4-0-0	4	EC1H 20B	Stochastic Process for Communication	4-0-0	4	EC1H 20C	Stochastic Signal Processing	4-0-0	4
S5	EC1H 30A	FPGA based System Design	4-0-0	4	EC1H 30B	Detection and Estimation Theory	4-0-0	4	EC1H 30C	Computational Tools for Signal Processing	4-0-0	4
S6	EC1H 30D	Electronic Design and Automation Tools	4-0-0	4	EC1H 30E	MIMO and Multiuser Communication Systems	4-0-0	4	EC1H 30F	Detection and Estimation Theory	4-0-0	4
S7	EC1H 40A	RF MEMS	4-0-0	4	EC1H 40B	Design and Analysis of Antennas	4-0-0	4	EC1H 40C	Multirate Signal Processing and Wavelets	4-0-0	4
S8	EC1H 49A	Mini Project	0-1-6	4	EC1H 49A	Mini Project	0-1-6	4	EC1H 49A	Mini Project	0-1-6	4

SEMESTER III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20A	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS	BSC	3	1	0	4	2020

i) COURSE OVERVIEW

This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. The basic theory of functions of a complex variable, residue integration and conformal transformation are discussed.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Solve partial differential equations.	Apply
CO 2	Use appropriate methods to solve one dimensional wave equation and heat equation.	Apply
CO 3	To solve problems using analyticity of complex functions	Apply
CO 4	Find the image of regions under conformal mapping	Apply
CO 5	Find complex integrals using Cauchy's formulas to compute several kinds of integrals.	Apply
CO 6	Find the series expansion of complex functions	Apply

iii) SYLLABUS

Partial differential equations: Formation of partial differential equations, Solutions of a partial differential equations, Linear equations of the first order, Method of separation of variables.

One dimensional wave equation-derivation and solution -One dimensional heat equation, derivation and solution

Complex Differentiation: Analytic functions, Cauchy-Riemann equations, harmonic functions, Conformal mappings- standard mappings, Linear fractional transformation .

Complex integration: Line integrals in the complex plane, Contour integrals, Cauchy integral theorem, Cauchy Integral formula

Taylor's series and Laurent's series, zeros of analytic functions, singularities, Residues, Cauchy Residue theorem, Evaluation of definite integral using residue theorem.

iv) (a) TEXT BOOKS

1) B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44th Edition, 2018.
2) Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, John Wiley & Sons,2016.

(a) REFERENCES

1) J. Stewart, *Essential Calculus*, Cengage, 2nd Edition, 2017
2) G.B. Thomas and R.L. Finney, *Calculus and Analytic geometry*, 9th Edition, Pearson, Reprint, 2002.
3) Peter V. O'Neil, *Advanced Engineering Mathematics*, Cengage, 7th Edition, 2012.

v) COURSE PLAN

Module	Contents	No. of hours
I	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order- Lagrange's linear equation, Non-linear equations of the first order - Charpit's method Boundary value problems, Method of separation of variables.	**12**
II	One dimensional wave equation- vibrations of a stretched string, Derivation. Solution of wave equation using method of separation of variables, Fourier series solution of boundary value problems involving wave equation, D'Alembert's solution of the wave equation. One dimensional heat equation, derivation. Solution of the heat equation, using method of separation of variables, Fourier series solutions of boundary value problems involving heat equation.	**13**
III	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations-harmonic functions, finding harmonic conjugate-Conformal mappings- mappings of $w = z^2, w = e^z, w = \frac{1}{z}, w = sinz$	**12**
IV	Complex integration, Line integrals in the complex plane, Basic properties, first evaluation method, second evaluation method, use of representation of a path-Contour integrals. Cauchy integral theorem (without proof) on simply connected domain, on multiply connected domain (without proof). Cauchy	**11**

	Integral formula (without proof). Cauchy Integral formula for derivatives of an analytic function Taylor's series and Maclaurin series.	
V	Laurent's series (without proof)-zeros of analytic functions, singularities, poles, removable-singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem-Residue integration of real integrals –integrals of rational functions of $cos\theta$ and $sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x)\, dx$ with no poles on the real axis. ($\int_{A}^{B} f(x)\, f(x)dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus)	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U20A	SOLID STATE DEVICES	PCC	3	1	0	4	2020

i) PREREQUISITE: ES0U10D Basics of Electrical and Electronics Engineering

ii) COURSE OVERVIEW

Goal of this course is to provide an insight into the basic semiconductor concepts. It also provide a sound understanding of current semiconductor devices and technology to appreciate its applications to electronics circuits and system

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the concepts of equilibrium carrier concentration and excess carriers in Semiconductors.	Understand
CO 2	Explain the carrier transport mechanisms in semiconductors.	Understand
CO 3	Illustrate the operation and characteristics of PN junction diode and bipolar junction transistors.	Apply
CO 4	Illustrate the principle of operation and characteristics of MOS devices.	Apply
CO 5	Discuss about scaling and short channel effects in MOSFETs.	Understand

iv) SYLLABUS

Semiconductor classification, Fermi Dirac distribution, Fermi level, Energy band diagram, Density of states, Equilibrium concentration of electrons and holes, Excess carriers in semiconductors, quasi Fermi levels.

Carrier transport in semiconductors, Hall Effect, Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations.

PN junctions- Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation, Metal Semiconductor contacts, Ohmic and Rectifying Contacts, Bipolar junction transistor, current components, Base width modulation.

Ideal MOS capacitor, band diagrams, threshold voltage, body effect, MOSFET-structure, types, Drain current equation.

MOSFET scaling – constant voltage scaling and constant field scaling. Sub threshold conduction in MOS, Short channel effects, FinFET –Structure, operation, and advantages.

v) a) TEXT BOOKS

1) Ben G. Streetman and Sanjay Kumar Banerjee, *Solid State Electronic Devices*, Pearson 6/e, 2010
2) Sung Mo Kang, *CMOS Digital Integrated Circuits: Analysis and Design*, McGraw-Hill, Third Ed., 2016
3) Neamen, *Semiconductor Physics and Devices*, McGraw Hill, 4/e, 2012

b) REFERENCES

1) Pierret, Semiconductor Devices Fundamentals, Pearson, 2006
2) Sze S.M., *Physics of Semiconductor Devices*, John Wiley, 3/e, 2005
3) Achuthan, K N Bhat, *Fundamentals of Semiconductor Devices*, 1e, McGraw Hill,2015\
4) Jan M.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits – A Design Perspective*, PHI.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Elemental and compound semiconductors, Intrinsic and Extrinsic semiconductors, concept of effective mass, Fermions-Fermi Dirac distribution, Fermi level, Doping; Energy band diagram, Equilibrium and steady state conditions, Density of states, Effective density of states, Equilibrium concentration of electrons and holes. Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi Fermi levels.	13
II	Carrier transport in semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect. Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi Fermi level.	13
III	PN junctions: Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation. Metal Semiconductor contacts, Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics. Bipolar junction transistor, current components, Transistor action, Base width modulation.	13
IV	Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, threshold voltage, body effect. MOSFET-structure, types, Drain current equation (derive)- linear and	11

	saturation region, Drain characteristics, transfer characteristics.	
V	MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling. Sub threshold conduction in MOS, Short channel effects- Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects. Non-Planar MOSFETs: Fin FET –Structure, operation and advantages	**10**
	Total hours	**60**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U20B	LOGIC CIRCUIT DESIGN	PCC	3	1	0	4	2020

i) PREREQUISITE:ES0U10D Basics of Electrical and Electronics Engineering

ii) COURSE OVERVIEW

The course aims at providing an idea about the digital circuits and the design of different functions effectively using basic building blocks.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the positional number systems and its arithmetic operations.	Understand
CO 2	Design combinational circuits using logic gates.	Apply
CO 3	Design the sequential circuits using the basic building blocks like flip-flops.	Apply
CO 4	Develop combinational and sequential logic circuits using hardware description language (HDL).	Apply
CO 5	Explain the different types of logic families with respect to performance and efficiency.	Understand

iv) SYLLABUS

Number Systems and Codes - Binary and hexadecimal number systems; Methods of base conversions; Binary and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating point numbers; Binary coded decimal codes; Gray codes; Excess 3 code. Alphanumeric codes: ASCII. Basics of verilog -- basic language elements: identifiers, data objects, scalar data types, operators.

Boolean Postulates and Fundamental Gates - Boolean postulates and laws – Logic Functions and Gates De-Morgan’s Theorems, Principle of Duality, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Canonical forms, Karnaugh map Minimization. Modeling in verilog, Implementation of gates with simple verilog codes.

Combinatorial and Arithmetic Circuits - Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder. Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder.Modeling and simulation of combinatorial circuits with verilog codes at the gate level.

Sequential Logic Circuits - Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Conversion of Flip Flops, Excitation table and characteristic equation. Implementation with verilog codes. Ripple and Synchronous counters and implementation in verilog, Shift registers-SIPO, SISO, PISO, PIPO. Shift Registers with parallel Load/Shift, Ring counter and Johnsons counter. Asynchronous and Synchronous counter design, Mod N counter. Modeling and simulation of flip flops and counters in verilog.

Logic families and its characteristics - TTL, ECL, CMOS - Electrical characteristics of logic gates – logic levels and noise margins,fan-out, propagation delay, transition time, power consumption and power-delay product. TTL inverter - circuit description and operation; CMOS inverter - circuit description and operation; Structure and operations of TTL and CMOS gates; NAND in TTL and CMOS, NAND and NOR in CMOS.

v) a) TEXT BOOKS

1) Morris Mano, *Digital Design*, Prentice Hall of India,6 /e, 2013.
2) Donald D Givone, *Digital Principles and Design*, Tata McGraw Hill, 2007.
3) Samir Palnikar,*Verilog HDL: A Guide to Digital Design and Synthesis*, Sunsoft Press, 2003.

b) REFERENCES

1) Ronald J Tocci, *Digital Systems*, Pearson Education, 11/e,2010.
2) Anand Kumar, *Fundamentals of Digital Circuits*, 4/e, 2016.
3) Wakerly J.F., *Digital Design: Principles and Practices*, Pearson India,4/e, 2008
4) Thomas L Floyd, *Digital Fundamentals*, Pearson Education, 11/e, 2018.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Binary and hexadecimal number systems; Methods of base conversions; Binary and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating pointnumbers; Binary coded decimal codes; Gray codes; Excess 3 code. Alphanumeric codes:ASCII. Basics of verilog -- basic language elements: identifiers, data objects, scalar data types, operators.	12

II	Boolean postulates and laws – Logic Functions and Gates De-Morgan's Theorems, Principle of Duality, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Canonical forms, Karnaugh map Minimization. Modeling in verilog, Implementation of gates with simple verilog codes.	12
III	Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder. Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder. Modeling and simulation of combinational circuits with verilog codes at the gate level.	12
IV	Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Conversion of Flipflops, Excitation table and characteristic equation. Implementation with verilog codes. Ripple and Synchronous counters and implementation in verilog, Shift registers-SIPO, SISO,PISO, PIPO. Shift Registers with parallel Load/Shift, Ring counter and Johnsons counter. Asynchronous and Synchronous counter design, Mod N counter. Modeling and simulation of flip flops and counters in verilog.	12
V	TTL, ECL, CMOS - Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product. TTL inverter - circuit description and operation; CMOS inverter - circuit description and operation; Structure and operations of TTL and CMOS gates; NAND in TTL and CMOS, NAND and NOR in CMOS.	12
	Total hours	**60**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	10 Marks
Continuous Assessment Tests (2 numbers)	25 Marks
Assignment/Quiz/Course project	15 Marks

It is mandatory that a *course project* shall be undertaken by a student for this subject. Instead of two assignments, two evaluations will be performed on the course project along with continuous assessment tests, each carrying 5 marks. Upon successful completion of the project, a brief report must be submitted by the student which will be evaluated for 5 marks.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U20C	NETWORK THEORY	PCC	3	1	0	4	2020

i) **PREREQUISITE:** ES0U10D: Basics of Electrical and Electronics Engineering, MA0U10B:Vector calculus, differential equations and transforms.

ii) COURSE OVERVIEW

The goal of this course is to expose the students to solve dc and ac networks using network theorems, to apply Laplace transform to determine the transient response of networks subjected to test signals and to analyse single and two ports network functions and its time domain response.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Apply the loop /nodal analysis/network theorems to solve dc and ac networks.	Apply
CO 2	Explain Laplace transform, properties and theorems.	Understand
CO 3	Apply Laplace Transforms to determine the transient behaviour of RLC networks.	Apply
CO 4	Use pole-zero plot to study the time domain response of a network.	Apply
CO 5	Analyse two port network parameters.	Apply

iv) SYLLABUS

Mesh and Node Analysis
Mesh and node analysis of network containing independent and dependent sources. Supermesh and Supernode analysis. Steady-state AC analysis using Mesh and Node analysis

Network Theorems
Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem. (applied to both dc and ac circuits having dependent source).

Application of Laplace Transforms
Review of Laplace Transforms and Inverse Laplace Transforms, Initial value theorem & Final value theorem, Transformation of basic signals and circuits into s-domain. Transient analysis of RL, RC, and RLC networks with impulse, step and sinusoidal inputs (with and

without initial conditions). Analysis of networks with transformed impedance and dependent sources.

Network functions

Network functions for the single port and two port network. Properties of driving point and transfer functions. Significance of Poles and Zeros of network functions, Time domain response from pole zero plot. Impulse Function & Response. Network functions in the sinusoidal steady state, Magnitude and Phase response.

Two port network Parameters

Impedance, Admittance, Transmission and Hybrid parameters of two port networks. Interrelationship among parameter sets. Series and parallel connections of two port networks. Reciprocal and Symmetrical two port network. Characteristic impedance, Image impedance and propagation constant (derivation not required).

v) (a) TEXT BOOKS

1) Valkenburg V., "Network Analysis", Pearson, 3/e, 2019.
2) Sudhakar A, Shyammohan S. P., "Circuits and Networks- Analysis and Synthesis", McGraw Hill,5/e,2015.

(b) REFERENCES

1) Edminister, "Electric Circuits – Schaum's Outline Series", McGraw-Hill, 2009.
2) Ravish R., "Network Analysis and Synthesis", 2/e, McGraw-Hill, 2015.
3) William D. Stanley, "Network Analysis with Applications", 4/e, Pearson, 2006.
4) K. S. Suresh Kumar, "Electric Circuits and Networks", Pearson, 2008.

vi) COURSE PLAN

Module	Contents	No. of hours
1.	Mesh and node analysis of network containing independent and dependent sources for dc and ac sources. Super mesh and super node analysis.	**12**
2.	Network theorems applied to dc and phasor circuits: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Millman's theorem, Maximum power transfer theorem.	**12**

3.	Laplace Transforms and inverse Laplace transform, initial value and final value theorem. Transformation of basic signals and circuits into s- domain. Transient analysis of RL, RC, and RLC networks with impulse, step, and sinusoidal inputs (with and without initial conditions).Analysis of networks with transformed impedance and dependent sources.	**12**
4.	Network functions for the single port and two port network. Properties of driving point and transfer functions. Significance of Poles and Zeros of network functions, time domain response from pole zero plot, impulse function & response. Network function in sinusoidal state, Magnitude and Phase response.	**12**
5.	Impedance, admittance, transmission and hybrid parameters of two port network, Interrelationship among parameter sets. Series and parallel connections of two port networks. Reciprocal and Symmetrical two port network. Characteristic impedance, image impedance and propagation constant (derivation not required)	**12**
	Total hours	**60**

Simulation assignment:

One assignment may be a simulation of steady state or transient analysis of R, L and C circuits.

viii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U20A	PROFESSIONAL ETHICS	HSC	2	0	0	2	2020

i) COURSE OVERVIEW

To enable students to create awareness on ethics and human values.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Infer the core values that shape the ethical behaviour of a professional.	Understand
CO 2	Apply philosophical concepts discussed in the course to personal and contemporary issues.	Apply
CO 3	Explain the role and responsibility of engineers in technological development without compromising personal ethics and legal ethics.	Understand
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.	Apply
CO 5	Demonstrate the concept of Corporate Social Responsibility, and explore its relevance to ethical business activity	Understand
CO 6	Apply the knowledge of human values and social values to contemporary ethical values and global issues.	Apply

iii) SYLLABUS

Morals, values and Ethics – Integrity- Academic Integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- Courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg’s theory- Gilligan’s theory- Consensus and Controversy- Profession and Professionalism- Models of professional Roles-Theories about right action – Self-Interest-Customs and Religion- Uses of Ethical Theories.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral Integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR

Discrimination.Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and Advisors-Moral leadership.

iv) (a) TEXT BOOKS

1) M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
2) R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi, 2006.

(b) REFERENCES

1) Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2) Charles D Fledder mann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3) Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4) http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

v) COURSE PLAN

Module	Contents	No. of hours
I	Morals, values and Ethics, Integrity, Academic Integrity, Work Ethics Service Learning, Civic Virtue, Respect for others, Living peacefully Caring and Sharing, Honesty, Courage, Co-operation commitment Empathy, Self Confidence, Social Expectations	6
II	Senses of Engineering Ethics, Variety of moral issues, Types of Inquiry- Moral dilemmas, Moral Autonomy, Kohlberg’s theory Gilligan’s theory, Consensus and Controversy, Profession & Professionalism, Models of professional roles, Theories about right action-Self-interest-Customs and Religion, Uses of Ethical Theories	6
III	Engineering as Experimentation, Engineers as responsible Experimenters-Codes of Ethics, Plagiarism, A balanced outlook on law- Challenger case study, Bhopal gas tragedy	6
IV	Collegiality and loyalty, Managing conflict, Respect for authority Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest-Occupational crime, Professional rights, Employee right, IPR, Discrimination	6

V	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics-Role in Technological Development, Moral leadership-Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	6
	Total Hours	**30**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20A	SUSTAINABLE ENGINEERING	MNC	2	0	0	-	2020

i) COURSE OVERVIEW

The objective of this course is to expose the students to the concept of sustainability, the global initiatives towards attaining sustainable development goals and the various sustainable practices. The students should realize the potential of technology in addressing environmental issues and bringing in sustainable solutions.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the relevance and the concept of sustainability and the global initiatives towards attaining sustainable development.	Understand
CO 2	Identify sustainable solutions for different types of environmental pollution problems	Apply
CO 3	Discuss the environmental regulations and standards, various tools for environmental management and clean development mechanism.	Apply
CO 4	Explain the concept of circular economy, bio-mimicking and the sustainable framework developed in industrial ecology and industrial symbiosis.	Apply
CO 5	Choose the best practice of nonconventional and sustainable energy depending on the available resources and its utilization.	Apply
CO6	Demonstrate the broad perspective of sustainable practices applicable for energy efficient buildings, green engineering, sustainable cities, sustainable urbanization, and sustainable transport.	Apply

iii) SYLLABUS

Sustainability- need and concept, Technology and Sustainable Development, Sustainable Development Goals.

Environmental Pollution: Natural resources and their pollution, Carbon credits, Zero waste concept and 3 R concepts, Clean Development Mechanism: Carbon Trading and Carbon footprint, legal provisions for environmental protection.

Environmental management standards: ISO 14001:2015 framework, Life Cycle Analysis, Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Resources and its utilization: Basic concepts of Conventional and non-conventional energy.

Sustainability practices: Sustainable habitat, Green buildings, green materials, Sustainable urbanization.

iv) (a) TEXTBOOKS

1) Bradley, A.S., Adebayo,A.O., Maria, P., *Engineering applications in sustainable design and development*, Cengage learning, 1st Edition, 2015.
2) Allen, D. T. and Shonnard, D. R., *Sustainability Engineering: Concepts, Design and Case Studies*, Prentice Hall, 1st Edition, 2011
3) Purohit, S.S., *Green Technology: An Approach For Sustainable Environment*, Agrobios (India), 1st Edition, 2021.
4) Janine, M.B., *Biomimicry: Innovation Inspired by Nature*, William Morrow Paperbacks, 2002

(b) REFERENCES

1) Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
2) ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System.

v) COURSE PLAN

Module	Contents	No. of hours
I	Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).	**6**
II	Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Clean Development Mechanism (CDM):Carbon credits, carbon trading and carbon footprint, legal provisions for environmental protection.	**6**
III	Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.	**6**
IV	Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind	**6**

	energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.	
V	Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.	**6**
	Total hours	**30**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U28A	SCIENTIFIC COMPUTING LAB	PCC	0	0	3	2	2020

i) PREREQUISITE: MA0U10A- Linear Algebra and Calculus**,**

MA0U10B -Vector calculus, Differential Equations and Transforms.

ii) COURSE OVERVIEW:

Objective of the course is to translate the mathematical concepts into system design using different computing tools.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Use a programming language for realization of arithmetic functions, vectorized computing and data visualization.	Apply
CO 2	Solve an array/matrix with matrix decomposition.	Apply
CO 3	Implement numerical integration and differentiation, ordinary differential equations for engineering applications.	Apply
CO 4	Implement the periodic functions using sinusoids.	Apply
CO 5	Examine random processes and their statistics.	Analyze

iv) SYLLABUS

Familiarization of a programming language for scientific computing and data visualization.

Solve ordinary differential equations, numerical integration and differentiation for engineering applications.

Solve periodic functions using Fourier analysis.

Solve array/matrix with matrix decomposition.

Simulate various random processes and compute absolute error to understand the law of large numbers.

v) REFERENCES

1) Peter I. Kattan, MATLAB for Beginners: A Gentle Approach, Createspace Independent Publications, 2008

vi) COURSE PLAN

Experiment No.	List of Exercises/Experiments	No. of hours
I	Familiarization of the Computing Tool. 1. Needs and requirements in scientific computing 2. Familiarization of a programming language like Python/R/ MATLAB/SCILAB/LabVIEW for scientific computing 3. Familiarization of data types in the language used. 4. Familiarization of the syntax of while, for, if statements. 5. Basic syntax and execution of small scripts.	5
II	Familiarization of Scientific Computing. 1. Functions with examples. 2. Basic arithmetic functions such as abs, sine, real, image, complex, sinc etc. using built in modules. 3. Vectorized computing without loops for fast scientific applications.	5
III	Realization of Arrays and Matrices. 1. Realize one dimensional array of real and complex numbers 2. Stem and continuous plots of real arrays using matplotlib/GUIs/charts. 3. Realization of two-dimensional arrays and matrices and their visualizations 4. Inverse of a square matrix and the solution of the matrix equation 5. Computation of the rank and eigen values a Matrix 6. Singular value decomposition 7. Plot the absolute error	5
IV	Numerical Differentiation and Integration. 1. Realize the functions sin t, cos t, sinht and cosht 2. Compute the first and second derivatives of these functions using	6

	built-in tools such as grad. 3. Plot the derivatives over the respective functions and appreciate. 4. Familiarize the numerical integration tools in the language you use. 5. Realize and plot the function. 6. Compare general integration tool with trapezoidal and Simpson method.	
V	Solution of Ordinary Differential Equations. 1. Solve the _first order and second order differential equation. 2. Solve for the current transient through the RC network and a series RLC network.	**6**
VI	Data visualization of simple functions /signals. 1. Draw stem plots, line plots, box plots, bar plots and scatter plots with random data. 2. Plot the histogram of a random data. 3. Create legends in plots. 4. Realize a vector 5. Implement and plot the functions	**6**
VII	Convergence of Fourier Series. 1. Realizethe Fourier series $\frac{4}{\pi}[1-\frac{1}{3} cos\ cos \frac{2\pi 3t}{T}+\frac{1}{5} cos\ cos \frac{2\pi 5t}{T}-\frac{1}{7} cos\ cos \frac{2\pi 7t}{T}+\cdots$. 2. Realize the vector t=[0.100] with an increment of 0.01 and keep T=20. 3. Plot the first 3 or 4 terms on the same graphic window and understand how the smooth sinusoids add up to a discontinuous square function. 4. Compute and plot the series for the first 10, 20, 50 and 100 terms and understand the lack of convergence at the points of discontinuity.	**6**
VIII	Coin Toss and the Level Crossing Problem 1. Simulate a coin toss that maps a head as 1 and tail as 0. 2. Toss the coin N = 100, 500,1000, 5000 and 500000 times and compute the probability (p) of head in each case. 3. Compute the absolute error and understand the law of large numbers.	**6**

	4. Create a uniform random vector with maximum magnitude 10, plot and observe. 5. Set a threshold and count how many times the random function has crossed threshold.	
	Total hours	**45**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	75	75	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	**15 Marks**
Continuous Assessment	**30 Marks**
Internal Test (Immediately before the II internal test)	**30 Marks**

End Semester Examination Pattern:

Preliminary work	**15 marks**
Implementing the work/Conducting the experiment	**20 marks**
Performance, result and inference (usage of equipment and troubleshooting):	**15 marks**
Viva voce	**20 marks**
Record	**5 Marks**

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Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U28B	LOGIC DESIGN LAB	PCC	0	0	3	2	2020

i) PREREQUISITE: ES0U18B - Electrical and Electronics Workshop

ii) COURSE OVERVIEW

Objective of the course is to familiarize the students with the Digital Logic Design through the implementation of Logic Circuits using ICs of basic logic gates and HDL based Digital Design Flow.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO1	Demonstrate the functioning of various combinational and sequential circuits using ICs	Apply
CO2	Apply an industry compatible hardware description language to implement digital circuits	Apply
CO3	Build digital circuits on FPGA boards and connect external hardware to the boards	Apply

iv) SYLLABUS

Design and realization of half /full adder and subtractor, 4 Bit adder subtractor, Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF, Asynchronous counters, Synchronous Counters, Multiplexers and De-multiplexers, Random Sequence generator.

Digital circuit design with Verilog and implementation in FPGAs- Adders, Multiplexers and De-multiplexers, Flip Flops and counters, Asynchronous and Synchronous Counters in FPGA, Universal Shift Register in FPGA, BCD to Seven Segment Decoder in FPGA

v) REFERENCES

1) Roth C.H., Fundamentals of Logic Design, Jaico Publishers. V Ed., 2009
2) Taub & Schilling: Digital Integrated Electronics, MGH, 2017.
3) W. I. Fletcher, An Engineering Approach to Digital Design, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1980
4) Tocci, R. J. and Widner, N. S., Digital Systems - Principles and Applications, Prentice Hall, 10th Ed., 2007

5) Wakerly J F, Digital Design: Principles and Practices, Prentice-Hall, 2nd Ed., 2002
6) Mano M. M., Computer System Architecture, Prentice Hall 1993.
7) Katz R, Contemporary Logic Design, Addison Wesley, 1993.
8) Lewin D. & Protheroe D., Design of Logic Systems, Chapman & Hall, University and Professional Division, 1992, II Ed.

v) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
	PART A: The following experiments can be conducted on breadboard or trainer kits.	
I	Design and Realization of half /full adder and subtractor using logic gates.	**3**
II	4 bit adder/subtractor and BCD adder using 7483.	**3**
III	Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.	**3**
IV	Asynchronous counters (using ICs 7476).	**3**
V	Synchronous Counters (using ICs 7473/7476).	**3**
VI	Realization of counters using IC’s (7490, 7492, 7493).	**3**
VII	Multiplexers and De-multiplexers using gates and ICs. (74150, 74154) 12. Realization of combinational circuits using MUX & DEMUX.	**3**
VIII	Random Sequence generator using LFSR.	**3**
	Part B: The following experiments aim at training the students in digital circuit design with Verilog and implementation in FPGAs.	
I	**Realization of Logic Gates and Familiarization of FPGA board.**	**3**
II	**Adders in Verilog** (a) Development of Verilog modules for half adder in 3 modelling styles (dataflow/structural/ behavioural). (b) Development of Verilog modules for full adder in structural modelling using half adder.	**3**

III	**Mux and Demux in Verilog** (a) Development of Verilog modules for a 4x1 MUX. (b) Development of Verilog modules for a 1x4 DEMUX.	**3**
IV	**Flipflops and Counters** (a) Development of Verilog modules for SR, JK and D flip flops. (b) Development of Verilog modules for a binary decade/Johnson/Ring counters	**3**
V	**Asynchronous and Synchronous Counters in FPGA** (a) Make a design of a 4-bit up down ripple counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board. (b) Make a design of a 4-bit up down synchronous counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board.	**3**
VI	**Universal Shift Register in FPGA** (a) Make a design of a 4-bit universal shift register using D-flip-flops , implement and test them on the FPGA board. (b) Implement ring and Johnson counters with it.	**3**
VII	**BCD to Seven Segment Decoder in FPGA** (a) Make a gate level design of a seven segment decoder, write to FPGA and test its functionality. (b) Test it with switches and seven segment display. Use output ports for connection to the display.	**3**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	75	75	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	15 Marks
Continuous Assessment	30 Marks
Internal Test (Immediately before the II internal test)	30 Marks

End Semester Examination Pattern:

Preliminary work	15 marks
Implementing the work/Conducting the experiment	20 marks
Performance, result and inference (usage of equipment and troubleshooting):	15 marks
Viva voce	20 marks
Record	5 Marks

MINORS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC0 M20A	ELECTRONIC CIRCUITS	MINOR (Basket-1)	3	1	0	4	2020

i) COURSE OVERVIEW:

This course introduces the concepts of basic electronic circuits and develop the skill of designing amplifiers, oscillators, and regulators.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the working of simple circuits using diodes, resistors, and capacitors.	Understand
CO 2	Analyse the transistor biasing circuits.	Analyze
CO 3	Design amplifier and oscillator circuits.	Apply
CO 4	Explain the working of MOSFETS, Power supplies, D/A and A/D converters.	Understand
CO 5	Design circuits using operational amplifiers and 555 IC.	Apply

iii) SYLLABUS

Wave shaping circuits: Sinusoidal and non-sinusoidal wave shapes, Principle and working of RC differentiating and integrating circuits, Clipping circuits - Positive, negative, and biased clipper. Clamping circuits - Positive, negative, and biased clamper.
Transistor biasing: Introduction, operating point, concept of load line, thermal stability (derivation not required), fixed bias, self-bias, voltage divider bias.

MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics.
Amplifiers: Classification of amplifiers, RC coupled amplifier – design and working, voltage gain and frequency response. Multistage amplifiers - effect of cascading on gain and bandwidth. Feedback in amplifiers - Effect of negative feedback on amplifiers.
MOSFET Amplifier- Circuit diagram, design and working of common source MOSFET amplifier.

Oscillators: Classification, criterion for oscillation, Wien bridge oscillator, Hartley, and Crystal oscillator. (design equations and working of the circuits; analysis not required).

Regulated power supplies: Review of simple zener voltage regulator, series voltage regulator, 3 pin regulators-78XX and 79XX, DC to DC conversion, Circuit/block diagram and working of SMPS.

Operational amplifiers: Characteristics of op-amps (gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp (IC741), Applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator, Comparator, Instrumentation amplifier.

Integrated circuits: D/A and A/D convertors – important specifications, Sample and hold circuit, R-2R ladder type D/A convertors. Flash and sigma-delta type A/D convertors. **Circuit diagram and working of Timer IC555**, astable and monostable multivibrators using 555.

iv) a) TEXT BOOKS

1) Boylestad and L Nashelsky, *Electronic Devices and Circuit Theory*, Pearson, 11/e, 2008.
2) Salivahanan S. and V. S. K. Bhaaskaran, *Linear Integrated Circuits*, Tata McGraw Hill, 3/e, ` 2008.

b) REFERENCES

1) David A Bell, *Electronic Devices and Circuits*, Oxford University Press, 2008.
2) Neamen D., *Electronic Circuits, Analysis and Design*, 3/e, TMH, 2007.
3) Millman J. and C. Halkias, *Integrated Electronics*, 2/e, McGraw-Hill, 2011.
4) Ramakant A Gayakwad, *Op-Amps and Linear Integrated Circuits*, 4/e,PHI, 2000.
5) K.Gopakumar, *Design and Analysis of Electronic Circuits*, Phasor Books, Kollam, 2013

v) COURSE PLAN

Module	Contents	No. of hours
I	**Wave shaping circuits:** Sinusoidal and non-sinusoidal wave shapes, Principle and working of RC differentiating and integrating circuits, Clipping circuits - Positive, negative, and biased clipper. Clamping circuits - Positive, negative, and biased clamper. **Transistor biasing:** Introduction, operating point, concept of load line, thermal stability (derivation not required), fixed bias, self-bias, voltage divider bias.	12
II	MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics. **Amplifiers:** Classification of amplifiers, RC coupled amplifier – design and working, voltage gain and frequency response. Multistage amplifiers - effect of cascading on	12

	gain and bandwidth. Feedback in amplifiers - Effect of negative feedback on amplifiers. MOSFET Amplifier- Circuit diagram, design and working of common source MOSFET amplifier.	
III	**Oscillators:** Classification, criterion for oscillation, Wien bridge oscillator, Hartley, and Crystal oscillator. (design equations and working of the circuits; analysis not required). **Regulated power supplies:** Review of simple zener voltage regulator, series voltage regulator, 3 pin regulators-78XX and 79XX, DC to DC conversion, Circuit/block diagram and working of SMPS.	**12**
IV	**Operational amplifiers: C**haracteristics of op-amps (gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp (IC741), Applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator, Comparator, Instrumentation amplifier.	**12**
V	**Integrated circuits:** D/A and A/D convertors – important specifications, Sample and hold circuit, R-2R ladder type D/A convertors. Flash and sigma-delta type A/D convertors. **Circuit diagram and working of Timer IC555**, astable and monostable multivibrators using 555	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC0M20B	ANALOG COMMUNICATION	MINOR (Basket-2)	4	0	0	4	2020

i) COURSE OVERVIEW

The goal of this course is to expose the students to different analog modulation schemes namely amplitude modulation and frequency modulation. Also it gives a brief overview on signal classification, LTI systems and Fourier Transform. It also gives a broad vision on different types of AM and FM transmitters and Receivers.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Discuss various components, sources of noise and it's effect in a communication system.	Understand
CO 2	Explain various analog modulation schemes in a communication system.	Understand
CO 3	Apply the knowledge of signals and system/modulation to study the behavior of a communication system.	Apply
CO 4	Discuss various transmitter and receiver systems of AM and FM.	Understand

iii) SYLLABUS

Introduction, Elements of communication systems, Examples of analog communication systems, Frequency bands, Need for modulation.
Noise in communication system, Definitions of Thermal noise (white noise), Various types of noise -- Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.

Brief overview of signals and systems -- Signals, Classification of signals, Energy and power of signals, Basic signal operations, Impulse function, Properties of impulse function, Convolution, LTI system, Fourier Transform, Basic properties, Using Fourier transform to study LTI system.

Amplitude modulation (AM), Double-side band suppressed carrier (DSB-SC) modulation
Single sideband modulation (SSB) – spectrum, power, efficiency of all the three variants. (Study of only tone modulation in DSB-SC, AM, and SSB.) Amplitude-

modulator implementations – switching modulator, balanced modulator. AM demodulators –Coherent demodulator. Envelope detector.

Frequency modulation – modulation index, frequency deviation, average power, spectrum of tone modulated FM. Heuristics for bandwidth of FM. Narrow band FM and wide-band FM. FM generation: Varactor diode modulator, Armstrong's method. FM demodulation –slope detection, PLL demodulator.

Superheterodyne receiver, Principle of Carrier synchronization using PLL, NTSC Television broadcasting.

iv)(a) TEXT BOOKS

1) Kennedy, Davis, *Electronic Communication Systems*, 4th Edition, Tata McGraw Hill,2008 .
2) Wayne Tomasi, *Electronic Communication Systems – Fundamentals through Advanced*, 5th edition, Pearson, 2008.
3) B.P.Lathi, Zhi Ding, *Modern Digital and Analog Communication Systems*, 4th edition, Oxford University Press,2017.

(b) REFERENCES

1) Leon W. Couch, *Digital and Analog Communication Systems*, 8th edition, Prentice Hall,2013

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction, Elements of communication systems, Examples of analog communication systems, Frequency bands, Need for modulation. Noise in communication system, Definitions of Thermal noise (white noise), Various types of noise -- Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.	12
II	Brief overview of signals and systems -- Signals, Classification of signals, Energy and power of signals, Basic signal operations, Impulse function, Properties of impulse function, Convolution, LTI system, Fourier Transform, Basic properties, Using Fourier transform to study LTI system.	12
III	Amplitude modulation (AM), Double-side band suppressed carrier (DSB-SC) modulation Single sideband modulation (SSB) – spectrum, power, efficiency of all the three variants. (Study of only tone modulation in DSB-SC, AM, and SSB.) Amplitude-modulator implementations – switching	12

	modulator, balanced modulator. AM demodulators -- Coherent demodulator. Envelope detector.	
IV	Frequency modulation – modulation index, frequency deviation, average power, spectrum of tone modulated FM. Heuristics for bandwidth of FM. Narrow band FM and wide-band FM. FM generation: Varactor diode modulator, Armstrong method. FM demodulation – slope detection, PLL demodulator	**12**
V	Super heterodyne receiver, Principle of Carrier synchronization using PLL, NTSC Television broadcasting.	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC0M20C	INTRODUCTION TO SIGNALS AND SYSTEMS	MINOR (Basket-3)	3	1	0	4	2020

i) COURSE OVERVIEW

The course aims to introduce various type of signals and systems in analog and discrete domain. It gives an insight into the properties and analysis of convolution integral and sum. It also deals with the frequency analysis of signals using fourier transform and introducing sampling theorem.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the concepts of Signals and Systems	Understand
CO 2	Apply properties and operations of signals and systems .	Apply
CO 3	Apply various transform techniques for analysing a signal in frequency domain	Apply
CO 4	Apply convolution for finding the response and transfer function of a system	Apply
CO 5	Describe correlation of discrete time signals	Understand
CO 6	Apply sampling theorem to discretize and analyse continuous time signals	Apply

iii) SYLLABUS

Introduction to continuous time signals: Definition of signal. Basic continuous-time signals. Frequency and angular frequency of continuous-time signals. Basic operation on signals. Classification of continuous-time signals: Periodic and Non-periodic signals. Even and Odd signals, Energy and power signals. Noise and Vibration signals.

Discrete time signals: Basic discrete-time signals. Frequency and angular frequency of discrete-time signals. Classification of discrete-time signals: Periodic and Non-periodic signals. Even and Odd signals, Energy and power signals.

Systems: System definition. Continuous-time and discrete-time systems. Properties – Linearity, Time invariance, Causality, Invertibility, Stability. Representation of systems using impulse response.

Linear time invariant systems: LTI system definition. Response of a continuous-time LTI system and the Convolutional Integral. Properties. Response of a discrete-time LTI system and the Convolutional Sum. Properties. Correlation of discrete-time signals.

Frequency Analysis of Signals: Concept of frequency in continuous-time and discrete-time signals. Fourier transforms of continuous-time and discrete-time signals. Parseval's theorem. Interpretation of Spectra. Case study of a vibration signal. Sampling theorem – perfect reconstruction of sampled signal.

iv) (a) TEXT BOOKS

1) Simon Haykin, Barry Van Veen, "Signals and systems", John Wiley, 2/e, 2007.
2) Hwei P Hsu, "Theory and problems of signals and systems", Schaum Outline Series, MGH, 1995.
3) Anders Brandt, "Noise and Vibration Analysis - Signal Analysis and Experimental Procedures", Wiley publication, 1/e, 2011.

(b) REFERENCES

1) Anand Kumar, "Signals and Systems", PHI, 3/e, 2013.
2) P Ramesh Babu, R. Ananda Natarajan, "Signals and Systems", 5/e, 2019.
3) Sanjay Sharma, "Signals and Systems", Kindle edition, 1/e, 2020.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to continuous time signals:** Definition of signal. Basic continuous-time signals. Frequency and angular frequency of continuous-time signals. Basic operation on signals. Classification of continuous-time signals: Periodic and Non-periodic signals. Even and Odd signals, Energy and power signals. Noise and Vibration signals	12
II	**Discrete time signals:** Basic discrete-time signals. Frequency and angular frequency of discrete-time signals. Classification of discrete-time signals: Periodic and Non-periodic signals. Even and Odd signals, Energy and power signals.	12
III	**Systems:** System definition. Continuous-time and discrete-time systems. Properties – Linearity, Time invariance, Causality, Invertibility, Stability. Representation of systems using impulse response	12

IV	**Linear time invariant systems:** LTI system definition. Response of a continuous-time LTI system and the Convolutional Integral. Properties. Response of a discrete-time LTI system and the Convolutional Sum. Properties. Correlation of discrete-time signals	**10**
V	**Frequency Analysis of Signals:** Concept of frequency in continuous-time and discrete-time signals. Fourier transforms of continuous-time and discrete-time signals. Parseval's theorem. Interpretation of Spectra. Case study of a vibration signal. Sampling theorem – perfect reconstruction of sampled signal.	**14**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

SEMESTER IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20C	PROBABILITY, RANDOM PROCESS AND NUMERICAL METHODS	BSC	3	1	0	4	2020

i) COURSE OVERVIEW

This course introduces students to the modern theory of probability and statistics, covering important models of random variables and analysis of random processes using appropriate time and frequency domain tools. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Identify the different discrete random experiments and find the probabilities of their occurrence	Apply
CO 2	Identify the different continuous random experiments and find the probabilities of their occurrence	Apply
CO 3	Examine random processes using autocorrelation, power spectrum and Poisson process model as appropriate.	Apply
CO 4	Find roots of equations, definite integrals and interpolating polynomial on given numerical data using standard numerical techniques	Apply
CO 5	Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations.	Apply

iii) SYLLABUS

Discrete random variables and their probability distributions, Binomial distribution, Poisson distribution, Discrete bivariate distributions, Expectation -multiple random variables.

Continuous random variables and their probability distributions-Uniform, exponential and normal distributions, Continuous bivariate distributions, Expectation-multiple random variables, i.i.d random variables and Central limit theorem.

Random processes and its classification, wide sense stationary (WSS) processes, power spectral density of WSS processes, Poisson process.

Roots of equations- Newton-Raphson, regula falsi methods. Interpolation-finite differences, Newton's forward and backward formula, Newton's divided difference method, Lagrange's method. Numerical integration.

Solution of linear systems-Gauss-Siedal and Jacobi iteration methods. Curve fitting-method of least squares, Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams- Moulton predictor-correction method

iv) (a) TEXT BOOKS

1) Jay L. Devore, Probability and Statistics for Engineering and the Sciences,8th edition, Cengage, 2012
2) Oliver C. Ibe, Fundamentals of Applied Probability and Random Processes,Elsevier, 2005.
3) Erwin Kreyszig, Advanced Engineering Mathematics, 10 th Edition, John Wiley & Sons, 2016.

(b) REFERENCES

1) Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes,Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2) V.Sundarapandian, Probability, Statistics and Queueing theory, PHI Learning, 2009
3) Gubner, Probability and Random Processes for Electrical and Computer Engineers,Cambridge University Press,2006.
4) B.S. Grewal, Higher Engineering Mathematics, KhannaPublishers, 36 Edition, 2010.

v) COURSE PLAN

Module	Contents	No. of hours
I	Discrete random variables and probability distributions, expected value, mean and variance (discrete). Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial. Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	12

II	Continuous random variables and probability distributions, expected value, mean and variance (continuous) Uniform, exponential and normal distributions, mean and variance of these distributions Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	12
III	Random process -definition and classification, mean , autocorrelation, WSS processes its autocorrelation function and properties. Power spectral density .Poisson process, inter-distribution of arrival time. combination of independent Poisson processes(merging) and subdivision (splitting) of Poisson processes	12
IV	Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation-finite differences, Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)	12
V	Solution of linear systems-Gauss-Siedal method, Jacobi iteration method Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares Solution of ODE-Euler and Classical Runge - Kutta methods of second and fourth order ,Adams-Moulton predictor-corrector methods	12
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	10 Marks
Continuous Assessment Tests (2 numbers)	25 Marks
Assignment/Quiz/Course project	15 Marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U20D	ANALOG CIRCUITS	PCC	3	1	0	4	2020

i) PREREQUISITE: ES0U10D Basics of Electrical and Electronics Engineering

ii) COURSE OVERVIEW

To develop the skill of analysis and design of various analog circuits using discrete electronic components and devices.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Design various RC circuits, Clipping, Clamping and biasing circuits.	Apply
CO 2	Analyse CE amplifier in low, mid and high frequency ranges.	Analyze
CO 3	Analyse biasing techniques of MOSFET, CS amplifier and Multistage amplifiers.	Analyze
CO 4	Analyse various Feedback amplifiers and an Oscillator	Analyze
CO 5	Explain the Principle of operation of Oscillators, Power amplifiers and transistor-based linear regulated power supplies	Understand

iv) SYLLABUS

Wave Shaping circuits- Differentiator, Integrator, First Order High pass and low pass RC circuits, Diode clipping and clamping circuits. Transistor biasing circuits.

Analysis of BJT Amplifier circuits- Small signal analysis of CE configuration, high frequency analysis of BJT CE amplifier.

Amplifiers - MOSFET amplifiers- Small signal analysis of CS configuration, Multistage Amplifiers – Cascade and Cascode, Feedback amplifiers, Power amplifiers.

Oscillators – Low frequency and High frequency, Regulated power supplies- Shunt**,** Series, Short circuit protection, fold back protection and current boosting.

v) (a) TEXT BOOKS

1) Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013
2) Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010

3) Robert Boylestad and L Nashelsky, Electronic Devices and Circuit Theory, 11/e Pearson, 2015

(b) REFERENCES

1) Neamen D., Electronic Circuits – Analysis and Design, 3/e, TMH, 2007
2) Razavi B., Fundamentals of Microelectronics, Wiley, 2015
3) Rashid M. H., Microelectronic Circuits – Analysis and Design, Cengage Learning, 2/e, 2011
4) David A Bell, "Electronic Devices and Circuits", Oxford University Press, 2008.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Wave shaping circuits:** First order RC differentiating and integrating circuits, First order RC low pass and high pass filters. Diode Clipping circuits – Positive, negative and biased clipper. Diode Clamping circuits – Positive, negative and biased clamper. **Transistor biasing:** Need, operating point, concept of DC load line, fixed bias, self-bias, voltage divider bias, bias stabilization.	**12**
II	**BJT Amplifiers:** Classification of amplifiers, RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines. **Small signal analysis of CE configuration** using small signal hybrid-pi model for mid frequency. (gain, input and output impedance). **High frequency equivalent circuits of BJT,** Miller effect, Analysis of high frequency response of CE amplifier, voltage gain and frequency response	**12**
III	**MOSFET amplifiers:** MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier, Small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration. CS stage with current source load, CS stage with diode-connected load. **Multistage amplifiers –** effect of cascading on gain and bandwidth. Cascode amplifier.	**11**
IV	**Feedback amplifiers:** Properties of positive and negative feedback on gain, frequency response and distortion. Analysis of the four basic feedback topologies, Analysis of discrete circuits in each feedback	**13**

	topologies –voltage gain, input and output impedance. **Oscillators:** Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis of Wien bridge oscillator only required)	
V	**Power amplifiers:** Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary-symmetry class B and Class AB power amplifiers, efficiency and distortion (no analysis required) **Linear Regulated power supplies:** Principle of Linear Regulated power supplies,Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting.	**12**
	Total hours	**60**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project *Atleast one assignment should be simulation of one type transistor amplifier on any circuit simulation software.*	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U20E	SIGNALS AND SYSTEMS	PCC	3	1	0	4	2020

i) COURSE OVERVIEW

This course aims to lay the foundational aspects of signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing, image processing, communication theory and control systems.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the concepts of Signals and Systems	Understand
CO 2	Apply properties of signals and systems to classify them	Apply
CO 3	Apply various transform techniques for representing a signal in frequency domain	Apply
CO 4	Apply convolution for finding the response and transfer function of a system.	Apply
CO 5	Describe correlation and orthogonality of signals	Understand
CO 6	Apply sampling theorem to discretize and analyse continuous time signals	Apply

iii) SYLLABUS

Elementary signals, Continuous time and Discrete time signals and systems, Signal operations, Differential equation representation, Difference equation representation, Continuous time LTI Systems, Discrete time LTI Systems, Correlation between signals, Orthogonality of signals, Frequency domain representation, Continuous time Fourier series, Continuous time Fourier transform, Using Laplace transform to characterize Transfer function, Stability and Causality using ROC of Transfer transform, Frequency response, Sampling, Aliasing, Z transform, Inverse Z transform, Unilateral Z-transform, Frequency domain representation of discrete time signals, Discrete time Fourier series and discrete time

iv) (a) TEXT BOOKS

1) Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2018
2) Simon Haykin, Signals & Systems, John Wiley, 2/e, 2003

(b) REFERENCES

1) Anand Kumar, Signals and Systems, PHI, 3/e, 2013.
2) Mahmood Nahvi, Signals and System, Mc Graw Hill (India), 2015.
3) P Ramesh Babu, R Anandanatarajan, Signals and System, 4^{th} Ed, 2014
4) Rodger E. Ziemer, Signals & Systems - Continuous and Discrete, Pearson, 4/e, 2013

v) COURSE PLAN

Module	Contents	No. of hours
I	Elementary Signals, Classification and representation of continuous time and discrete time signals, Signal operations. Continuous time and discrete time systems – Classification, Properties. Representation of systems: Differential equation representation of continuous time systems. Difference equation representation of discrete systems. Continuous time LTI systems and convolution integral Discrete time LTI systems and linear convolution. Stability and causality of LTI systems. Correlation between signals, Orthogonality of signals.	**16**
II	Frequency domain representation of continuous time signals - continuous time Fourier series and its properties. Continuous time Fourier transform and its properties. Convergence and Gibbs phenomenon Review of Laplace Transform, ROC of Transfer function, Properties of ROC, Stability and causality conditions. Relation between Fourier and Laplace transforms.	**14**
III	Analysis of LTI systems using Laplace and Fourier transforms. Concept of transfer function, Frequency response, Magnitude and phase response. Sampling of continuous time signals, Sampling theorem for lowpass signals, aliasing.	**10**
IV	Frequency domain representation of discrete time signals, Discrete time Fourier series for discrete periodic signals. Properties of DTFS. Discrete time Fourier transform (DTFT) and its properties. Analysis of discrete time LTI systems using DTFT. Magnitude and phase	**10**

	response.	
V	Z transform, ROC, Inverse transform, properties, Unilateral Z transform. Relation between DTFT and Z-Transform, Analysis of discrete time LTI systems using Z transform, Transfer function. Stability and causality using Z transform.	**10**
	Total hours	**60**

Simulation Assignments

The following simulations to be done in Scilab/ Matlab/ LabView/GNU Octave:

1. Generate basic discrete time signals
2. Generate linear convolution
3. Generate different signals as combinations of basic signals
4. Write a function for simulating DTFT of a signal.
5. Realize an LTI system with a given system response

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U20F	COMPUTER ARCHITECTURE AND MICROCONTROLLERS	PCC	3	1	0	4	2020

i) PREREQUISITE: ES0U10E - Programming in C, EC1U20B - Logic Circuit Design

ii) COURSE OVERVIEW

This course aims to introduce the architectures of computers and microcontrollers. It gives an insight into programming using assembly language and interfacing of 8051 microcontroller with peripheral devices.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the functional units, I/O and memory management of a typical computer.	Understand
CO 2	Explain the architecture of 8051 and ARM microcontrollers.	Understand
CO 3	Apply the knowledge of addressing modes and instructions to develop assembly language programs for 8051 microcontrollers.	Apply
CO 4	Interface 8051 microcontrollers with various peripheral devices.	Apply
CO 5	Explain memory hierarchy and different I/O accessing techniques used in computer systems.	Understand

iv) SYLLABUS

Computer Arithmetic and Processor Basics:
Algorithms for binary multiplication and division. Fixed and floating point number representation. Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution (basic concepts, datapath).

8051 Architecture:
Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts, Assembly

Language Programming - Addressing Modes, Instruction set (Detailed study of 8051 instruction set is required).

Programming and Interfacing of 8051:
Simple programming examples in assembly language, interfacing with 8051 using Assembly language programming: LED, Seven segment LED display. Programming in C – Declaring variables, Simple examples – delay generation, port programming, code conversion.
Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC -- with 8051 and its programming.

Advanced Concepts:
8051 Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially. Introduction to ARM – ARM family, ARM 7 register architecture. ARM programmer's model. System software - Assembler, Interpreter, Compiler, Linker, Loader, Debugger.

The Memory System:
Types of memory - RAM, ROM. Memory Characteristics and Hierarchy. Cache memory – The basics of Caches, Mapping techniques, Improving Cache performance. Virtual memory – Overlay, Memory management, Address translation- Input/Output Organization – Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.

v) a) TEXT BOOKS

1) M.A.Mazidi, J. G. Mazidi and R. D. McKinlay, *The 8051 Microcontroller and EmbeddedSystems: Using Assembly and C*, Pearson Education, Second edition, 2011.
2) Stallings W., *Computer Organisation and Architecture*, 10/e, Pearson Education, 2018
3) Steve Furber, *ARM System - on-chip Architecture*, Pearson Education, 2/e, 2001

b) REFERENCES

1) David A. Patterson, John L. Hennessy, *Computer organization and design: The Hardware/Software interface*, Morgan Kaufmann Publishers,5/e, 2014.
2) Subrata Ghoshal, *Computer Architecture and Organization: From 8085 to Core2Duo and beyond*, Pearson, 1/e, 2011.
3) V. Carl Hamacher, Zvonko G. Vranesic, Safwat G.Zaky ,*Computer Organisation*, Mc GrawHill Education, 5/e, 2001.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Algorithms for binary multiplication and division. Fixed and floating point number representation. Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution (basic concepts, datapath).	12
II	Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly Language Programming - Addressing Modes, Instruction set (Detailed study of 8051 instruction set is required).	12
III	Simple programming examples in assembly language. Interfacing with 8051 using Assembly language programming: LED, Seven segment LED display. Programming in C – Declaring variables, Simple examples – delay generation, port programming, code conversion. Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC -- with 8051 and its programming.	12
IV	8051 Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially. Introduction to ARM – ARM family, ARM 7 register architecture. ARM programmer's model. System software - Assembler, Interpreter, Compiler, Linker, Loader, Debugger.	12
V	Types of memory - RAM, ROM. Memory Characteristics and Hierarchy. Cache memory – The basics of Caches, Mapping techniques, Improving Cache performance. Virtual memory – Overlay, Memory management, Address translation. Input/Output Organization – Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.	12
	Total hours	**60**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

It is mandatory that a *course project* shall be undertaken by a student for this subject. The course project must be performed as a hardware realization of a typical embedded system using Embedded C/ Assembly Language Programming. Instead of two assignments, two evaluations will be performed on the course project along with continuous assessment tests, each carrying 5 marks. Upon successful completion of the project, a brief report must be submitted by the student which will be evaluated for 5 marks.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U20A	DESIGN AND ENGINEERING	ESC	2	0	0	2	2020

i) PREREQUISITE: Nil. It's generic to all engineering disciplines.

ii) COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental principles of design engineering. Students are expected to apply design thinking in learning, which is very important and relevant for today. The course also focuses on familiarizing the students with the aesthetics, ergonomics and sustainability factors in designs and practice professional ethics while designing.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Demonstrate the different stages involved in design engineering process	Understand
CO 2	Compose a problem statement with design objectives taking into account the customer requirements, design constraints and functionality.	Create
CO 3	Develop innovative solutions to the Design problem through brainstorming and ideation.	Apply
CO 4	Identify the concepts of Biomimicry, Aesthetics and Ergonomic factors in designs to add more value to it.	Apply
CO 5	Apply the Design communication tools to model an idea.	Apply
CO6	Incorporate different segments of knowledge in engineering in order to develop innovative, reliable, sustainable and economically viable designs.	Apply

iv) SYLLABUS

Introduction to engineering design. Generate a design through the Design Process stages.

Design Thinking Approach, Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning.

Ideation in Design Thinking - Brainstorming sessions. Design Engineering Concepts. Application of Biomimicry, Aesthetics and Ergonomics in Design. Design for X – Quality, Reliability and Sustainability

Design Communication, Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept.

Value Engineering, Concurrent and Reverse Engineering. Expediency, Economics and Environment in Design Engineering. Design Rights. Ethics in Design.

v) (a) TEXT BOOKS

1) Yousef Haik, Sangarappillai Sivaloganathan, Tamer M. Shahin, *Engineering Design Process*, Third Edition, Cengage Learning, (1 January 2017)
2) Linda C. Schmidt , George Dieter, *Engineering Design*, McGraw Hill Education; Fourth edition (1 July 2017)
3) Pavan Soni, *Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving*, Penguin Random House India Private Limited, 2020
4) Voland, G., *Engineering by Design*, Pearson India 2014, Second Edition, ISBN 9332535051

(b) REFERENCES

1) Clive L Dym, *Engineering Design: A Project Based Introduction*, Fourth Edition, John Wiley & Sons, New York 2009.
2) Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, Harper Business; Revised, Updated ed. edition (5 March 2019)
3) Don Norman , *The Design of Everyday Things*, Basic Books; 2 edition (5 November 2013)
4) Dominique Forest , *Art of Things: Product Design Since 1945*, Abbeville Press Inc.,U.S.; Special edition (16 October 2014)
5) Javier Abarca, Al Bedard, et al, *Introductory Engineering Design – A Projects-Based Approach*, 3rd ed, Regents of the University of Colorado, 2000.
6) Nigel Cross, Design Thinking: *Understanding How Designers Think and Work*, Berg Publishers 2011, First Edition, ISBN: 978-1847886361
7) Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., *Engineering Design: A Systematic Approach*, Springer 2007, Third Edition, ISBN 978-1-84628-319-2.
8) George Dieter , *Engineering Design: A Materials and Processing Approach*, McGraw-Hill Education / Asia; 3 edition (16 February 2000)

vi) COURSE PLAN

Module	Contents	No. of hours
I	Design Process: - Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	3
	Practical Exercise: Need Identification. How to define a Problem Statement. Present an idea using the stages of the Design Process.	3
II	Design Thinking Approach: -Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Empathize – User Persona, Day in the Life Technique, identify customer requirements using Morphological Chart and set design objectives. Define - Identifying and formulating a Problem Statement -Fish Bone Diagram	4
	Practical Exercise: User Persona Chart. Morphological Chart	2
III	Ideate - Brainstorming sessions, and ideation using Random word technique, SCAMPER. Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Application of Biomimicry, Aesthetics and Ergonomics in Design. Design for X – Quality, Reliability and Sustainability.	4
	Practical Exercise: Brainstorming, 6-3-5 technique, Random Word Technique	2
IV	Design Communication: - Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept. Awareness of Basic tools of Design like – Autodesk, CATIA, MATLAB	3
	Practical Exercise: Communicating Designs Graphically.	4
V	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. Expediency, Economics and Environment in Design Engineering: - Design for Production, Use, and Sustainability. Engineering	3

	Economics in Design. Design Rights. Ethics in Design	
	Practical Exercise: Case Studies	**2**
	Total hours	**30**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B.Part A: 30 marks and part B : 70 marks. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question.Students should answer all questions.Part B contains 2 case study questions from each module of which student should answer any one.Each question carry 14 marks and can have maximum 2 sub questions.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20B	CONSTITUTION OF INDIA	MNC	2	0	0	---	2020

i) PREAMBLE:

The study of the Constitution of India enables the students to

1) Understand the fundamental rights & duties and directive principles
2) Understand the functions of Executive, Legislature and Judiciary of the Union and the States
3) Understand the relation between the Union and the States
4) Provides the student the knowledge and strength to face the society and people.

ii) COURSE OUTCOMES:

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

Course Outcomes	Description	Level
CO 1	Explain the historical background of the constitution of India and its features.	Understand
CO 2	Describe the fundamental rights, duties and directive principles of state policy.	Understand
CO 3	Discuss the machinery of executive, legislature and judiciary of the Union and the States.	Understand
CO4	Explain the relation between the Union and the States.	Understand

iii) SYLLABUS

Constitution of India: Definition, historical background, features, preamble, territory, citizenship. State, fundamental rights, directive Principles, fundamental duties. The machinery of the union government, machinery of the state governments. Statutory institutions, miscellaneous provisions, amendments to constitution.

iv)(a) TEXT BOOKS

1) M. Laxmikanth, Indian Polity, McGraw Hill Education India, 6/e, 2019.
2) D. D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi, 24/e, 2019.
3) P. M. Bhakshi, The Constitution of India, Universal Law, 14/e, 2017.

(b) REFERENCES

1) Ministry of Law and Justice, The Constitution of India, Govt. of India, New Delhi, 2019.
2) J. N. Pandey, The Constitutional Law of India, Central Law agency, Allahabad, 51/e, 2019.
3) M. V.Pylee, India's Constitution, S. Chand and Company, New Delhi, 16/e, 2016.

v) COURSE PLAN

Module	Contents	No. of hours
I	Definition of constitution, historical background, salient features of the constitution. Preamble of the constitution, union and its territory. Meaning of citizenship, types, termination of citizenship.	4
II	Definition of state, fundamental rights, general nature, classification, right to equality, right to freedom, right against exploitation. Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences. Directive principles of state policy, classification of directives, fundamental duties.	7
III	The Union Executive, the President, the Vice President, the Council of Ministers, the Prime Minister, Attorney-General, functions. The parliament, composition, Rajya sabha, Lok sabha, qualification and disqualification of membership, functions of parliament. Union judiciary, the supreme court, jurisdiction, appeal by special leave.	7
IV	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories. The State Legislature, composition, qualification and disqualification of membership, functions. The state judiciary, the high court, jurisdiction, writs jurisdiction.	6
V	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission. Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals. Official language, elections, special provisions relating to certain classes, amendments to constitution.	6
	Total hours	**30**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	10 Marks
Continuous Assessment Tests (2 numbers)	25 Marks
Assignment/Quiz/Course project	15 Marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U28C	ANALOG CIRCUITS AND SIMULATION LAB	PCC	0	0	3	2	2020

i) COURSE OVERVIEW

Objective of this course is to familiarize the students with the Analog Circuits Design through the implementation of basic Analog Circuits using discrete components and simulation of basic Analog Circuits.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Implement the basic analog circuits using discrete components.	Analyze
CO 2	Simulate analog circuits using EDA tools.	Analyze

iii) SYLLABUS

Experiments using Discrete components

RC integrating and differentiating circuits, Clipping and clamping circuits, RC coupled CE amplifier, Cascade amplifier, Low frequency oscillator, Transistor series voltage regulator.

Simulation Experiments
RC integrating and differentiating circuits, Clipping and clamping circuits, MOSFET amplifier, Cascode amplifier, Feedback amplifiers, Power amplifiers

iv) REFERENCES

1) Navas K A, Electronics Lab Manual, Volume 1, PHI Learning Private Limited, 5th Edition, 2015.

v) COURSE PLAN

Experiment No.	Part A List of experiments using discrete components	No. of hours
I	RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)	**4**

II	Clipping and clamping circuits (Transients and transfer characteristics)	**4**
III	RC coupled CE amplifier - frequency response characteristics	**4**
IV	Cascade amplifier – gain and frequency response	**4**
V	Low frequency oscillator –RC phase shift	**4**
VI	Transistor series voltage regulator (load and line regulation)	**4**
	Part B: **Simulation Experiments**	
I	RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)	**3**
II	Clipping and clamping circuits (Transients and transfer characteristics)	**3**
III	MOSFET amplifier (CS) - frequency response characteristics	**3**
IV	Cascode amplifier -frequency response	**4**
V	Feedback amplifiers (current series, voltage series) - gain and	**4**
VI	Power amplifiers (transformer less) - Class B and Class AB frequency response	**4**
	Total hours	**45**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	75	75	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	**15 Marks**
Continuous Assessment	**30 Marks**
Internal Test (Immediately before the II internal test)	**30 Marks**

End Semester Examination Pattern:

Preliminary work	**15 marks**
Implementing the work/Conducting the experiment	**20 marks**
Performance, result and inference (usage of equipment and troubleshooting):	**15 marks**
Viva voce	**20 marks**
Record	**5 Marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1U28D	MICROCONTROLLER LAB	PCC	0	0	3	2	2020

i) PREREQUISITE: ES0U10E Programming in C

ii) COURSE OVERVIEW:

The objective of the course is to impart practical experience to students by exposing them todevelop the Assembly Language/embedded C programming of Microcontrollers and to interface simple peripheral devices to a Microcontroller.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Develop assembly language programs/Embedded C programs for performing data manipulation.	Apply
CO 2	Develop assembly language programs/ C programs with IDE for microcontrollers.	Apply
CO 3	Develop assembly language programs to interface 8051 module with various peripheral modules	Apply

iv) SYLLABUS

Develop assembly language programs/Embedded C programs for performing data manipulation.

Develop the Interfacing of 8051 module with various peripheral modules.

v) REFERENCES

1) Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, The 8051 microcontroller and Embedded System, Pearson Education, 2nd edition.
2) Steve Furber, ARM System - on-chip Architecture, Pearson Education,2nd edition.

vi) COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
	PART A: These experiments shall be performed using 8051 trainer kit. The programs shall be written either in embedded C or in assembly language.	

I	Addition and Subtraction of 16 bit data.	**6**
II	Sum of a series of 8 bit data.	**3**
III	Square ,cube , square root of 8 bit data.	**6**
IV	Data transfer/exchange between specified memory locations	**3**
V	Largest/smallest from a series	**3**
VI	Sorting (Ascending/Descending) of data.	**3**
VII	LCM and HCF of two 8 bit numbers.	**3**
VIII	Code conversion – Hex to Decimal/ASCII to Decimal and vice versa.	**3**
	Part B: Interfacing experiments shall be done using modern microcontrollers such as 8051 or ARM. The interfacing modules may be developed using Embedded C	
I	Display and keyboard interface with 8051/ARM.	**3**
II	ADC Interface with 8051/ARM.	**3**
III	DAC Interface with 8051/ARM.	**3**
IV	Stepper motor and DC motor interface.	**3**
V	Realization of Boolean expression through port	**3**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	75	75	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	15 Marks
Continuous Assessment	30 Marks
Internal Test (Immediately before the II internal test)	30 Marks

End Semester Examination Pattern:

Preliminary work	15 marks
Implementing the work/Conducting the experiment	20 marks
Performance, result and inference (usage of equipment and troubleshooting):	15 marks
Viva voce	20 marks
Record	5 Marks

MINORS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC0M 20D	MICROCONTROLLERS	MINOR (Basket-1)	3	1	0	4	2020

i) COURSE OVERVIEW

This course aims to impart the overview of a microcontroller-based system design and interfacing techniques.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the building blocks of a typical microcomputer/microcontroller system.	Understand
CO 2	Apply the knowledge of addressing modes and instructions to develop assembly language programs for 8051 microcontrollers.	Apply
CO 3	Interface the various peripheral devices to the 8051-microcontroller using assembly language program.	Apply
CO 4	Develop microcontroller-based applications using Open-Source Embedded Development boards.	Apply
CO 5	Explain the architecture of 8051, ATmega 2560 and ARM microcontrollers.	Understand

iii) SYLLABUS

Computer Arithmetic and Processor Basics: Functional units of a computer, Von Neumann and Harvard computer architectures, Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute.

8051 Architecture: Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts, Addressing Modes, Instruction set (brief study of 8051 instruction set).

Programming and Interfacing of 8051: Simple assembly language programs- addition, subtraction, multiplication, and division. Interfacing of LCD display, Keyboard, Stepper Motor, DAC, and ADC - with 8051 and its programming.

Open-Source Embedded Development Boards - Introduction to ATmega 2560 microcontroller - block diagram and pin description, Introduction to Arduino Mega 2560 board, Simple applications- Solar tracker, 4- digit 7 segment LED display, Tilt sensor, Home security alarm system, Digital Thermometer, IoT applications.

ARM Based System:
Introduction - ARM family, ARM 7 register architecture. ARM programmer's model. Introduction to Raspberry pi 4 board, Applications- Portable Bluetooth speaker, remote controlled car, Photo Booth, IoT weather station, Home automation centre, Portal Digital eBook Library.

iv) a) TEXT BOOKS

1) Subrata Ghoshal, Computer Architecture and Organization: From 8085 to Core 2 Duo and beyond, Pearson, 2011.
2) M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C",Pearson Education, Second edition, 2011.
3) Steve Furber, ARM System - on-chip Architecture, Pearson Education, 2001.

c) REFERENCES

4) Stallings W., Computer Organisation and Architecture, 5/e, Pearson Education, 2019.
5) https://www.microchip.com/wwwproducts/en/ATmega2560
6) www.arduino.cc
7) www.raspberrypi.org

v) COURSE PLAN

Module	Contents	No. of hours
I	**Computer Arithmetic and Processor Basics:** Functional units of a computer, Von Neumann and Harvard computer architectures, Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute.	**12**

II	**8051 Architecture:** Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts, Addressing Modes, Instruction set (brief study of 8051 instruction set).	**12**
III	**Programming and Interfacing of 8051:** Simple assembly language programs- addition, subtraction, multiplication, and division. Interfacing of LCD display, Keyboard, Stepper Motor, DAC, and ADC -with 8051 and its programming.	**12**
IV	**Open-Source Embedded Development Boards** - Introduction to ATmega 2560 microcontroller - block diagram and pin description, Introduction to Arduino Mega 2560 board, Simple applications- Solar tracker, 4- digit 7 segment LED display, Tilt sensor, Home security alarm system, Digital Thermometer, IoT applications.	**12**
V	**ARM Based System:** Introduction - ARM family, ARM 7 register architecture. ARM programmer's model. Introduction to Raspberry pi 4 board, Applications- Portable Bluetooth speaker, remote controlled car, Photo Booth, IoT weather station, Home automation centre, Portal Digital eBook Library.	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ECTM 204	DIGITAL COMMUNICATION	MINOR (Basket-2)	3	1	0	4	2020

i) PREREQUISITE: EC0M20B -ANALOG COMMUNICATION

ii) COURSE OVERVIEW

The goal of this course is to expose the students to various sources coding schemes and signalling codes in telephony. It also gives an idea on various modulation and channel coding schemes in a digital transmission system.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain various source coding schemes.	Understand
CO 2	Describe various signalling codes in telephony.	Understand
CO 3	Apply the knowledge of digital modulation schemes in a digital transmission system.	Apply
CO 4	Explain various channel coding techniques and receivers in a digital transmission system.	Understand

iv) SYLLABUS

Linear Source Coding
Elements of digital communication system. Sources, channels and receivers.Classification of communication channels. Discrete sources. Source coding techniques. Waveform coding methods. Sampling theorem. Sampling and reconstruction. Pulse code modulation. Sampling, quantization and encoding. Different quantizers. A-law and mu-law quantization. Practical 15 level mu and A law encoding.

Nonlinear Source Coding
Differential PCM, adaptive PCM, Delta modulator and adaptive delta modulator. Issues in delta modulation. Slope overload.

Signaling Codes in Telephony
Signalling codes in digital telephony. T1 signalling system. AMI and Manchester codes. Binary N-zero substitution, B3ZS code, B6ZS code.

Digital Modulation Schemes
Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK transmitter and receiver. Baseband QPSK system and Signal constellations. Plots of BER Vs SNR (Analysis not required). QPSK transmitter and receiver. Quadrature amplitude modulation.

Channel Coding and Receivers
Transmission through AWGN Channel. Capacity of an AWGN channel. Receivers. Correlation and matched filter receiver. Channel coding schemes. Repetition code. Block codes Cyclic codes.

v) (a) TEXT BOOKS

1) Simon Haykin, *Communication Systems*, 4/e ,Wiley India, 2012
2) John G. Proakis, Masoud Salehi, *Digital Communication*, 5/e McGraw Hill Education Edition, 2014

(b) OTHER REFERENCES

1) John C. Bellamy, *Digital Telephony*, 3/e,Wiley,2000.
2) H.Taub and Schilling, P*rinciples of Communication Systems*, TMH, 2007.
3) Couch, *Digital and Analog Communication Systems*, 8/e, Pearson Education India, 2013.
4) Ramakrishna Rao, Digital communication, Tata McGraw Hill Education Pvt. Limited, 2017.

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Linear Source Coding:** Elements of digital communication system. Sources, channels and receivers. Classification of communication channels. Discrete sources. Source coding techniques. Waveform coding methods. Sampling theorem. Sampling and reconstruction. Pulse code modulation. Sampling, quantization and encoding. Different quantizers. A-law and mu-law quantization. Practical 15 level mu and A law encoding.	12
II	**Nonlinear Source Coding:** Differential PCM, adaptive PCM, Delta modulator and adaptive delta modulator. Issues in delta modulation. Slope overload.	12
III	**Signaling Codes in Telephony :** Signaling codes in digital telephony. T1 signalling system. AMI and Manchester codes. Binary N-zero substitution, B3ZS code, B6ZS code.	12
IV	**Digital Modulation:** Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK transmitter and receiver. Base band QPSK system and Signal constellations. Plots of BER Vs SNR(Analysis not required). QPSK transmitter and receiver. Quadrature amplitude	12

	modulation.	
V	**Channel Coding and Receivers:** Transmission through AWGN Channel. Capacity of an AWGN channel. Receivers. Correlation and matched filter receiver. Channel coding schemes. Repetition code. Block codes Cyclic codes.	**12**
	Total hours	**60**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC0M20F	INTRODUCTION TO DIGITAL SIGNAL PROCESSING	MINOR (Basket-3)	3	1	0	4	2020

i) **PREREQUISITE:** EC0M20C – Introduction to Signals and Systems

ii) **COURSE OVERVIEW**: The course aims to introduce the concept of converting a continuous time signal to its digital versions and its analysis using Fourier transform.It also deals with the design and realization of FIR and IIR filters and practical limitations of their implementation. It gives an introduction about the structure of a DSP processor.

iii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain how digital signals are obtained from continuous time signals	Understand
CO 2	Apply the concepts to analyse digital signals using Fourier transform	Apply
CO 3	Apply the concepts to design analog and digital filters	Apply
CO 4	Apply the concepts to analyse the practical limitations in DSP implementation	Apply
CO 5	Explain the structure of a DSP architecture	Understand

iv) SYLLABUS

Signal Processing Fundamentals: Discrete-time and digital signals. Basic elements of digital processing system- ADC, DAC and Nyquist rate. Frequency aliasing due to sampling. Need for anti-aliasing filters. Discrete Time Fourier Transforms – Properties. Computation of spectrum

Discrete Fourier Transform – Properties and Application: Discrete Fourier transform - DFT as a linear transformation, Properties - circular convolution. Filtering of long data Sequences - FFT-Radix-2 DIT and DIF algorithms. Computational complexity of DFT and FFT –application

Digital Filters: Digital FIR Filter: Transfer function - Difference equation, Linear phase FIR filter, Concept of windowing, Direct form and cascade realization of FIR and IIR filters. Digital IIR Filters - Transfer function, Difference equation. Direct and parallel Structures. Design of analogue Butterworth filters, Analog frequency transformations, Impulse invariance method. Bilinear transformation, Analog prototype to digital transformations.

Finite word length effects in digital filters and DSP Hardware: Fixed point arithmetic, Floating point arithmetic, Truncation and Rounding, Quantization error in ADC, Overflow error, Product round off error, Scaling, Limit cycle oscillation.

General and special purpose hardware for DSP: Computer architectures for DSP – Harvard, pipelining, MAC, special instruction, replication, on chip cache. General purpose digital signal processors (TMS 320 family) - Implementation of digital filtering on DSP processor. Special purpose DSP hardware.

v) (a) TEXT BOOKS

1) John G Proakis, G. Manolakis, "*Digital Signal Processing : Principles , Algorithms, and Applications*", Pearson Education, New Delhi, 4/e, 2007.
2) Alan V. Oppenheim, Ronald W. Schafer, "*Discrete time signal processing*", Prentice Hall, 3/e, 2009.
3) Rulph chasseing, "*Digital Signal Processing and applications with C6713 and C6416 DSK*", Wiley, Kindle edition, 2005.

(b) REFERENCES

1) Sanjit K Mitra, "*Digital Signal Processing, A Computer based Approach*", Tata McGraw-Hill, New Delhi, 4/e, 2011.
2) Emmanuel I. feacher, and Barrie W. Jervis, "*Digital Signal Processing-A Practical Approach*", Pearson Education, 2/e, 2011
3) Ramesh Babu, "Digital Signal Processing", Scitech Publications, 7/e, 2017

vi) COURSE PLAN

Module	Contents	No. of hours
I	**Signal Processing Fundamentals:** Discrete-time and digital signals. Basic elements of digital processing system- ADC, DAC and Nyquist rate. Frequency aliasing due to sampling. Need for anti-aliasing filters. Discrete Time Fourier Transforms – Properties. Computation of spectrum	12
II	**Discrete Fourier Transform – Properties and Application** Discrete Fourier transform - DFT as a linear transformation, Properties - circular convolution. Filtering of long data sequences - FFT-Radix-2 DIT	14

	and DIF algorithms. Computational complexity of DFT and FFT - application	
III	**Digital Filters** Digital FIR Filter: Transfer function - Difference equation, Linear phase FIR filter, Concept of windowing, Direct form and cascade realization of FIR and IIR filters. Digital IIR Filters - Transfer function, Difference equation. Direct and parallel Structures. Design of analogue Butterworth filters, Analog frequency transformations, Impulse invariance method. Bilinear transformation, Analog prototype to digital transformations	**14**
IV	**Finite word length effects in digital filters and DSP Hardware** Fixed point arithmetic, Floating point arithmetic, Truncation and Rounding, Quantization error in ADC, Overflow error, Product round off error, Scaling, Limit cycle oscillation.	**10**
V	**General and special purpose hardware for DSP:** Computer architectures for DSP – Harvard, pipelining, MAC, special instruction, replication, on chip cache. General purpose digital signal processors (TMS 320 family) - Implementation of digital filtering on DSP processor. Special purpose DSP hardware	**10**
	Total hours	**60**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

HONOURS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1H20A	NANOELECTRONICS	Honours (Basket-1)	4	0	0	4	2020

i) **PREREQUISITE**: PH0U10A Engineering Physics A , EC1U20A Solid State Devices

ii) **COURSE OVERVIEW**:
The goal of this course is to introduce the students to the fundamental concepts of nanoelectronics and nanoelectronic devices.

iii) **COURSE OUTCOMES**

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

Course Outcomes	Description	Level
CO 1	Explain the fundamental concepts associated with low dimensional semiconductors.	Understand
CO 2	Explain the methods of fabrication of nanoparticles and nanolayers.	Understand
CO 3	Describe the various characterization tools for nanomaterials.	Understand
CO 4	Describe the carrier transport mechanisms in different nano devices.	Understand
CO 5	Discuss the structure and operation of various nanoscale devices.	Understand

iv) **SYLLABUS**

Introduction to nanotechnology- characteristic lengths in mesoscopic systems , Quantum mechanical coherence- Low dimensional structures, Quantum wells, wires and dots, Density of states of 1D and 2D nanostructures-Square, parabolic and triangular quantum wells – basic properties.

Introduction to methods of fabrication of nanolayers- physical vapour deposition – evaporation and sputtering, chemical vapour deposition, Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide. Fabrication of nanoparticles- grinding with iron balls, laser ablation, reduction methods, sol gel, self-assembly, precipitation of quantum dots.

Introduction to characterization of nanostructures: Principle of operation of Scanning, Tunnelling Microscope, Atomic Force Microscope, Scanning Electron microscope – Specimen interactions, Transmission Electron Microscope, X-Ray diffraction analysis.
Quantum wells, modulation doped quantum wells, multiple quantum wells, Concept of super lattices, Kronig - Penney model of super lattice. Transport of charge in Nanostructures-Electron scattering mechanisms, Hot electrons, Resonant tunnelling transport, Coulomb blockade, Effect of magnetic field on a crystal. Aharonov-Bohm effect, the Shubnikov-de Hass effect.
Nanoelectronic devices - MODFET, Single electron Transistor, CNT transistors, Properties of graphene, Resonant tunnel effect – RTD, RTT, Hot electron transistors, Quantum well laser, quantum dot LED, quantum dot laser.

v) (a) TEXT BOOKS

1) J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda, Nanotechnology for Microelectronics and optoelectronics, Elsevier, 2006.
2) W.R. Fahrner, Nanotechnology and Nanoelectronics, Springer, 2005
3) Chattopadhyay, Banerjee, Introduction to Nanoscience & Technology, PHI, 2012.

(b) REFERENCES

1) George W. Hanson, Fundamentals of Nanoelectronics, Pearson Education, 2009.
2) Murty, Shankar, Text book of Nanoscience and Nanotechnology, Universities Press, 2012.
3) Supriyo Dutta, Quantum Transport- Atom to transistor, Cambridge, 2013.

vi) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to nanotechnology, Limitations of conventional microelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence. Low dimensional structures - Quantum wells, wires and dots, Density of states of 1D and 2D nanostructures. Basic properties of square quantum wells of finite depth, parabolic and triangular quantum wells	13
II	Introduction to methods of fabrication of nano-layers: physical vapour deposition- evaporation & Sputtering, Chemical vapour deposition, Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods. Fabrication of nanoparticles- grinding with iron balls, laser ablation, reduction methods, sol gel, self assembly, precipitation of quantum dots.	12

III	Introduction to characterization of nanostructures: Principle of operation of Scanning Tunnelling, Microscope, Atomic Force Microscope, Scanning Electron microscope - specimen interaction, X- Ray Diffraction analysis	**11**
IV	Quantum wells, multiple quantum wells, Modulation doped quantum wells, concept of super lattices Kronig - Penney model of super lattice. Transport of charge in Nanostructures - Electron scattering mechanisms, Hot electrons, Resonant tunnelling transport, Coulomb blockade, Effect of magnetic field on a crystal. Aharonov- Bohm effect, the Shubnikov-de Hass effect.	**13**
V	Nanoelectronic devices - MODFETS, Single Electron Transistor, CNT transistors – Properties of graphene Resonant tunnel effect, RTD, RTT, Hot electron transistors Quantum well laser, quantum dot LED, quantum dot laser	**11**
	Total hours	

vii) ASSESSMENT PATTERN

viii) Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1H20B	STOCHASTIC PROCESSES FOR COMMUNICATION	Honours (Basket-2)	4	0	0	4	2020

i) COURSE OVERVIEW:

This course aims to apply the concepts of probability and random processes in communication systems.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Apply the concepts of probability, random variables and stochastic processes	Apply
CO 2	Apply the concepts in probability to statistically characterize communication channels	Apply
CO 3	Apply the concepts of probability to find information and entropy	Apply
CO 4	Explain source coding and channel coding theorem.	Understand
CO 5	Explain stochastic processes in data transmission	Understand

iii) SYLLABUS

Review of Probability and Random Variables-

Review of probability- Relative frequency and Axiomatic definitions of probability, Significance of axiomatic definition; Bayes theorem and conditional probability, Independence.

Discrete random variables- The cumulative distribution and density functions for discrete random variables; Joint distribution and conditional distribution;

Statistical averages-Mean, Variance and standard deviation, Gaussian density function, Pdf of envelop of two Gaussian variables – Rayleigh Pdf.

Review of Random Processes –

Stochastic Processes- Stationarity and ergodicity; WSS and SSS processes; Gaussian Random process, Mean and autocorrelation and power spectral density functions; Weiner Kinchine theorem, Bandwidth of a random process, PSD of a Pulse Amplitude Modulated wave. White noise, Filtering of discrete WSS process by LTI systems; Noise-equivalent bandwidth, Signal to Noise Ratio, Matched Filter, Band-limited and narrowband random process; Sum of random variables, Markov Inequality, Chebyshev Inequality, Convergence, The central limit theorem (statement only). Gaussianity of thermal noise.

Entropy and Information-
Basics of discrete communication system, Sources, channels and receivers; Discrete memoryless sources; Entropy; Source coding theorem (statement only); Mutual Information; Discrete memoryless channels; Matrix of channel transmission probabilities; Noiseless and noisy channels, binary symmetry channels; Channel coding theorem (statement only) Channel capacity for BSC (derivation required), Differential entropy, Channel capacity of AWGN channel (statement only).
Markov Process and Queuing Theory-
Markov process- Definition and model, Markov chain- Transition probability matrix, State diagram and characteristics of a Markov chain; Chapman Kolmogorov equation; Poisson process.
Queues in Communication Networks-
Overview of queuing theory. M/M/1, M/M/∞, Application to packet transmission in a slotted ALOHA computer communication network.

iv) a) TEXT BOOKS

1) Papaulis and Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes, 4/e, MH, 2002.

2) Hsu, Analog and Digital Communication Systems, Schaum Outline Series, 3/e, 2017, MGH.

b) REFERENCES

1) John G Proakis ,Masoud Salehi, Digital Communications, 5/e, MGH, 2018.

2) Miller and Childers, Probability and Random Processes, 2/e, Academic Press, 2012.

3) Bertsekas and Gallager, Data Networks, 2/e, PHI,2015.

v) COURSE PLAN

Module	Contents	No. of hours
I	Review of probability- Relative frequency and Axiomatic definitions of probability, Significance of axiomatic definition. Bayes theorem and conditional probability. Independence. Discrete random variables. The cumulative distribution and density functions for discrete random variables. Joint distribution and conditional distribution. Statistical averages. Mean, Variance and standard deviation, Gaussian density function, Pdf of envelop of two gaussian variables – Rayleigh Pdf.	**12**
II	Stochastic Processes- Stationarity and ergodicity. WSS and SSS processes. Gaussian Random process, Mean and autocorrelation and power spectral density functions. Weiner Kinchine theorem, Bandwidth	**12**

	of a random process, PSD of a Pulse Amplitude Modulated wave. White noise, Filtering of discrete WSS process by LTI systems. Noise equivalent bandwidth, Signal to Noise Ratio, Matched Filter, Band-limited and narrowband random process. Sum of random variables, Markov Inequality, Chebyshev Inequality, Convergence, The central limit theorem (statement only). Gaussianity of thermal noise.	
III	Basics of discrete communication system, Sources, channels and receivers. Discrete memoryless sources. Entropy. Source coding theorem (statement only). Mutual Information. Discrete memoryless channels. Matrix of channel transmission probabilities. Noiseless and noisy channels, binary symmetry channels. Channel coding theorem (statement only) Channel capacity for BSC (derivation required), Differential entropy, Channel capacity of AWGN channel (statement only).	**12**
IV	Markov process. Definition and model. Markov chain. Transition probability matrix. State diagram and characteristics of a Markov chain. Chapman Kolmogorov equation. Poisson process	**12**
V	Overview of queuing theory. M/M/1, M/M/∞ systems Application to packet transmission in a slotted ALOHA computer communication network.	**12**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
EC1H20C	STOCHASTIC SIGNAL PROCESSING	Honours (Basket-3)	3	1	0	4	2020

i) COURSE OVERVIEW:

The course aims to introduce the stochastic systems and their interactions with LTI systems.

ii) COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the concepts of probability, random variables and stochastic processes	Understand
CO 2	Apply the concepts in probability to statistically analysing the signals	Apply
CO 3	Apply the properties of WSS for finding the LTI system response	Apply
CO 4	Apply the concepts to model discrete systems using various methods	Apply
CO 5	Explain the concepts to estimate the spectra of signals using various methods	Understand

iii) SYLLABUS

Review of Probability and Random Variables: Review of probability. Relative frequency and Axiomatic definitions of probability, Significance of axiomatic definition. Bayes theorem and conditional probability. Independence. Discrete random variables. The cumulative distribution and density functions for random variables. Joint distribution
and conditional distribution. Statistical averages. Mean, Variance and standard deviation, Functions of random variables. Multivariate Gaussian density function.
Review of Random Processes: Stochastic Processes. Stationarity and ergodicity. WSS and SSS processes. Discrete Gaussian, Rayleigh and Rician processes. Sums of random variables, Convergence, Markov and Chebyshev inequality, The central limit theorem (statement only).
The Autocorrelation Matrix and its Significance: Statistical averages of discrete stationary stochastic processes. Mean and autocorrelation and power spectral density functions. Weiner Kinchine theorem, Filtering of discrete WSS process by LTI

systems. The autocorrelation matrix and the significance of its eigen vectors. Whitening. Properties of autocorrelation matrix, its inversion and Levinson-Durbin Recursion. Wiener-Hopf equation. Brownian motion, its mathematical model and its autocorrelation and power spectral density

Signal Modeling - Deterministic and Stochastic: The least square method of signal modeling. The Pade approximation. Prony's method. Stochastic models, AR, MA and ARMA models.

Spectrum Estimation: Periodogram method of spectrum estimation. Parametric methods AR, MA and ARMA methods

iv)(a) TEXT BOOKS

1) Monson Hayes, "*Statistical Digital Signal Processing and Modelling*", John Wiley and Sons, 4/e, 2002.
2) A. Papaulis and Unnikrishna Pillai, "*Probability, Random Variables and Stochastic Processes*", McGraw Hill, 4/e, 2017

(b) OTHER REFERENCES

1) V. Sundarapandian, "*Probability, Statistics and Queueing theory*", PHI Learning, 2009
2) Hossein Pishro-Nik, "*Introduction to Probability, Statistics and Random Processes*", https://www.probabilitycourse.com, Kappa Research LLC, 2014.
3) Oliver C Ibe, "*Fundamentals of Applied Probability and Random Processes*", Elsevier, 2/e, 2014.
4) T Veerarajan "*Probability Statistics and Random Process*", McGraw Hill, 3/e, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Review of probability and random variables:** Review of probability. Relative frequency and Axiomatic definitions of probability, Significance of axiomatic definition. Bayes theorem and conditional probability. Independence. Discrete random variables. The cumulative distribution and density functions for random variables. Joint distribution and conditional distribution. Statistical averages. Mean, Variance and standard deviation, Functions of random variables. Multivariate Gaussian density function	**14**
II	**Review of probability and random processes:** Stochastic Processes. Stationarity and ergodicity. WSS and SSS processes. Discrete Gaussian, Rayleigh and Rician processes. Sums of random variables, Convergence, Markov and Chebyshev inequality, The central limit theorem (statement only)	**13**
III	**Autocorrelation matrix and its significance:**	**13**

	Statistical averages of discrete stationary stochastic processes. Mean and autocorrelation and power spectral density functions. Weiner Kinchine theorem, Filtering of discrete WSS process by LTI systems. The autocorrelation matrix and the significance of its eigen vectors. Whitening. Properties of autocorrelation matrix, its inversion and Levinson-Durbin Recursion. Wiener-Hopf equation. Brownian motion, its mathematical model and its autocorrelation and power spectral density	
IV	**Signal Modelling - Deterministic and Stochastic:** The least square method of signal modeling. The Pade approximation. Prony's method. Stochastic models, AR, MA and ARMA models	**10**
V	**Spectrum estimation:** Periodogram method of spectrum estimation. Parametric methods AR, MA and ARMA methods.	**10**
	Total hours	**60**

vi) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain10questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.