MANIPAL UNIVERSITY JAIPUR

School of Business & Commerce

Department of Business Administration
Course Hand-out

Value, Ethics & Governance | BB 0025 | 1 Credits | 2 0 0 2

Session: July 23 – Dec 23 | Faculty: Dr Anjalee Narayan | Class: BTech III Semester

A. COURSE INTRODUCTION: This course helps students to improve understanding of values, ethics and governance so that we help them become responsible citizens of the country.

B. COURSE OUTCOMES: At the end of the course, students will be able to

[0025.1] To improve understanding of values, ethics, and corporate governance so that we produce responsible citizens for the larger society.
[0025.2] Define the meaning and relevance of value and ethics and apply in personal and professional life.
[0025.3] Describe the importance of three Gunas for self-development, lifelong learning, and growth.
[0025.4] Explain the relevance of Companies Act 2013 with reference to corporate world.
[0025.5] Find issues and identify solutions related to public and private governance systems.
[0025.6] Demonstrate the social and environmental responsibilities of corporate for sustainability, harmony and growth.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

[PO.2]. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

[PO.3]. Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

[PO.4]. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

[PO.5]. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

[PO.6]. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

[PO.7]. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life- long learning in the broadest context socio technological changes.

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. Understanding Traditional and Contemporary Managerial Concepts and Models: Understanding in detail, the contents of various functional areas of Business & Management and the implications of psychological and behavioural aspects on the organizations.

[PSO.2]. Analyzing Business Environment: Identifying opportunities existing in the domestic and global business and economic environment and initiating systematic approach towards rational decision making.

[PSO.3]. Application of Business Concepts and Managerial Skills: Implementing conceptual knowledge in real business situations for ensuring business sustainability and growth.

D. ASSESSMENT PLAN:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	20
	Sessional Exam II	20
	In Class Assignments	20
End Term Exam (Summative)	End Term Exam	40
	Total	100

E. SYLLABUS

Value: Meaning & Relevance of Value Education. **Mantra for Success**: Meaning & perspective of Values, Morals & Ethics, Determinants of human nature (Three Gunas), Kinds of Value and their relevance with examples. Understanding Harmony at Various Levels, Nature, in existence. **Relevance of Personality traits like** Attitude & Behaviour, Sigmund Freud Theory of Ego, Character, introspection, Motivation. **Leadership traits:** 4Qs (PQ, IQ, EQ, SQ), Professional Ethics, Ethical Conflict, Ethical Dilemmas. **Governance:** Understanding of Public and Private sector Governance systems, **Companies Act 2013:** Its Salient Features, Roles & Responsibilities of Directors & Regulatory Authorities. Public Finance: – Scope, Principals, Role of Audit & Control, Relevance of Ethics in Governance. **Corporate Social Responsibility (CSR):** Meaning, Importance and Responsibility under CSR, CSR Models, Best Practices & Triple Bottom Line concept.

F. TEXTBOOKS

No textbooks for this course/ Recorded video of contents are provided.

G. REFERENCE BOOKS

- Gaur R.R., Sangal R. and. Bagaria, G.P: "A Foundation Course in Human Values Professional Ethics," Excel Books, 2010.
- Sadri S & Sadri, J Business Excellence Through Ethics & Governance, 2nd edition, 2015
- Mathur, U C Corporate Governance and business ethics, MacMillan India Ltd, Latest Edition
- Baxi, C V: Corporate Governance, Excel Books, Latest Edition
- Sadri S, Sinha A K and Bonnerjee, P: Business Ethics: concepts and cases, TMH, Latest Edition

H. LECTURE PLAN:

SESSION NO.	TOPICS	Session Objective	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
Lecture/Video 1	Introduction of the course, Syllabus	To acquaint and clear teacher's expectations and understand student expectations.	Lecture, Presentation	BB0025.1	Mid Term I End Term Exam
Lecture/Video 2	Introduction: Values: Meaning & Relevance of value education	To learn the Basics of Value Education and its relevance.	Lecture, Presentation	BB0025.1	Mid Term I End Term Exam
Lecture /Video 3	Success: Meaning in perspective of morals & ethics	To understand the concept of success achieved with or without	Lecture, Presentation	BB0025.1	Mid Term I End Term Exam

		morals / ethics/ values.			
Lecture/Video 4	Three Gunas and their relevance, Nature, and kinds of value with examples	To understand basic traits in one's personality, its causes and relevance with value-based living.	Lecture, Presentation	BB0025.3	Mid Term I End Term
Lecture/Video 5	Understanding Harmony at Various Levels, Nature, in existence	To acquaint with the concepts of harmony at various levels.	Lecture, Presentation	BB0025.1 BB0025.2	Mid Term I End Term
Lecture/Video 6	Relevance of Personality	To acquaint & develop positive traits of personality in oneself.	Lecture, Presentation	BB0025.3	Mid Term I End Term
Lecture/Video 7	Relevance of Attitude & Behaviour	To acquaint & develop positive traits of personality in oneself.	Lecture, Presentation	BB0025.2	Mid Term I End Term
Lecture/Video 8	Sigmund Freud Theory of Ego	To understand the concepts of theory of ego	Lecture, Presentation	BB0025.3	Mid Term I End Term
Lecture/Video 9	Character, introspection, Motivation	To acquaint & develop positive traits of personality in oneself and understand negative traits.	Lecture, Presentation	BB0025.2	Mid Term I End Term
Lecture/Video 10	Leadership traits	To realize importance of leadership and to imbibe in life.	Lecture, Presentation	BB0025.2	Mid Term I End Term
Lecture/Video 11	4Qs (PQ, IQ, EQ, SQ)	To acquaint with 4Qs.	Lecture, Presentation	BB0025.2	Mid Term I End Term
Lecture/Video 12	Professional Ethics	To understand the role of professional ethics in the life & deal with dilemmas.	Lecture, Presentation	BB0025.1 BB0025.2	Mid Term I End Term Exam
Lecture/Video 13	Ethical Conflict	To understand the importance of ethical conflict.	Lecture, Presentation	BB0025.1 BB0025.2	Mid Term I End Term Exam
Lecture/Video 14	Ethical Dilemmas	To understand the role of professional ethics in the life & deal with dilemmas.	Lecture, Presentation	BB0025.1 BB0025.2	Mid Term I End Term Exam
Lecture/Video 15	Introduction to Governance	To acquaint with the concept of Governance.	Lecture, Presentation	BB0025.5	Mid Term II End Term
Lecture/Video 16	Public Sector Governance: Part I	To understand various aspects	Lecture, Presentation	BB0025.5	Mid Term II End Term

		of public sector governance.			
Lecture/Video 17	Public Sector Governance: Part II	To understand various aspects of public sector governance.	Lecture, Presentation	BB0025.5	Mid Term II End Term
Lecture/Video 18	Companies Act 2013: Roles & Responsibilities of Directors & Regulatory Authorities	To explain various Regulations and practices of Corporate Governance internationally & understand key role of directors.	Lecture, Presentation	BB0025.4	Mid Term II End Term
Lecture/Video 19	Companies Act 2013: Salient Features	To explain various Regulations and practices of Corporate Governance internationally & understand key role of directors.	Lecture, Presentation	BB0025.4	Mid Term II End Term
Lecture/Video 20	Private Sector Governance	To understand meaning of proprietary & partnership in a firm / company and its perspectives.	Lecture, Presentation	BB0025.5	Mid Term II End term
Lecture/Video 21	Public Finance: – Scope & Principals	To understand basics of Public Finance, audit & control.	Lecture, Presentation	BB0025.5	End Term
Lecture/Video 22	Public Finance: - Audit & Control	To understand basics of Public Finance, audit & control.	Lecture, Presentation	BB0025.5	End Term
Lecture/Video 23	Relevance of Ethics in Governance	To recognize the necessity of ethics & transparency in Governance.	Lecture, Presentation	BB0025.1 BB0025.5	End Term
Lecture/Video 24	CSR: Meaning, Importance and Responsibility under CSR	To understand the relevance of giving back to society by a corporate & its importance in society.	Lecture, Presentation	BB0025.6	End Term
Lecture/Video 25	CSR: Models and Best Practices	To understand the various models of CSR used by corporates and their best practices.	Lecture, Presentation	BB0025.6	End Term
Lecture/Video 26	CSR: Policy	To understand CSR policy of India and its	Lecture, Presentation	BB0025.6	End Term

		impact on Business organisation.			
Lecture/Video 27	Triple Bottom Line	To understand the concept of TBL in organizational frameworks.	Lecture, Presentation	BB0025.6	End Term

I. COURSE ARTICULATION MATRIX: (MAPPING OF COS WITH POS)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES							CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
BB0025.1	To improve understanding of values, ethics, and corporate governance so that we produce responsible citizens for the larger society.	1						2		1	
BB0025.2	Define the meaning and relevance of value and ethics and apply in personal and professional life.		2								2
BB0025.3	Describe the importance of three Gunas for self-development, lifelong learning, and growth.		3					3		2	
BB0025.4	Explain the relevance of Companies Act 2013 with reference to corporate world.	2							3		
BB0025.5	Find issues and identify solutions related to public and private governance systems.				1	2					
BB0025.6	Demonstrate the social and environmental responsibilities of corporate for sustainability, harmony, and growth.						2	2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Basic Sciences

Department of Mathematics and Statistics

Course Hand-out

Engineering Mathematics III | MA2109 | 3 Credits | 3 0 0 3

Session: July 23 – Dec 23 | Faculty: Dr. Sunil Joshi| Class: III Semester

A. **Introduction:** In the first part the student will be acquainted with Fourier series and Fourier transformation which is necessary for engineering problem solution. some Partial differential equation like Basic concepts, solutions of heat, wave equations by separation of variables and numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit method which are suitable for modelling various problems of practice. The other part of the subject yields' fundamental knowledge from the vector calculus and real-life applications of Linear Programming Problems and Transportation problems.

B. **Course Outcomes:** At the end of the course, students will be able to the student is able to think logically.

[2109.1.1]. Understand the periodic function and solve the problems using Fourier series and Fourier transform

[2109.2]. Understand the Fourier Transforms and their applications in engineering

[2109.3]. Ability to solve the problems using Laplace, heat and wave equations

[2109.4]. Learn about vector calculus and their applications in engineering

[2109.5]. Learn real life engineering problem based on LPP and Transportation problems

PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.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

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. To solve complex practical problems related to electrical & electronics engineering applications by applying and correlating the knowledge gained from mathematics, basic sciences and other fundamental courses.

[PSO.2]. To design, develop and analyse the prevalent domains of electrical systems for sustainable, reliable, environmental friendly and feasible solutions.

[PSO.3]. Develop, investigate and solve different models of electrical networks using modern engineering tools for variety of real time, industrial and research problems.

C. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Mid Term Exam	30
	Quizzes and Assignments , and attendance	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

D. SYLLABUS

MA2109: ENGINEERING MATHEMATICS III [2 1 0 3]

Vector calculus Gradient, divergence, and curl. Line, surface, and volume integrals. Greens, Gauss divergence and Stokes theorems.

Fourier series of periodic functions Half range expansions. Harmonic analysis.

Fourier transform, Fourier integrals. Sine and cosine integrals, sine and cosine transforms.

Partial differential equation Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One dimensional wave equation, one dimensional heat equation and their solutions.

Optimizations Basic concepts, Linear programming, Graphical and Simplex methods, penalty cost and two-phase methods. Transportation problems.

E. References:

1. Dean G. Duffy, *Advanced Engineering Mathematics with MATLAB*, CRC Press, 2016. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. Alan Jeffrey, *Advanced Engineering Mathematics*, Academic Press, 2001.
3. A Taha Hamdy, *Operation research*, (7e), Inc. Pearson Education, 2014.

Lec No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Fourier series of periodic functions	Understand the concept of periodic functions and their Fourier series	Lecture	MA2109.1	Home Assignments, Class quiz and End Tear Exam
2	Change of interval	Able to find the Fourier series for different interval	Lecture	MA2109.1	
3	Half range expansions	Able to find the Fourier series in for the half interval	Lecture	MA2109.1	
4, 5	Harmonic analysis	Able to do Harmonic analysis	Lecture	MA2109.1	
6, 7	Fourier integrals	Understand the concept Fourier integrals	Lecture	MA2109.2	
8,9	Sine and cosine integrals	Understand the concept Sine and cosine integrals	Lecture	MA2109.2	
10	Fourier transform	Able to find the Fourier transform of functions	Lecture	MA2109.2	

11	Sine and cosine transforms	Able to find the Sine and cosine transforms of functions	Lecture	MA2109.2	Home Assignments, Class quiz and End Tear Exam
12	Basics, review	Recall and learn vectors property	Lecture	MA2109.4	
13	Gradient	Understand the concept Gradient	Lecture	MA2109.4	
14	Divergence, Curl	Understand the concept Divergence, Curl	Lecture	MA2109.4	
15	Line Integral	Understand the concept vector Line Integral	Lecture	MA2109.4	
17	Surface Integral	Understand the concept vector Surface Integral	Lecture	MA2109.4	
18	Volume Integral	Understand the concept vector Volume Integral	Lecture	MA2109.4	
19	Green's theorem and its Examples	Understand the concept of Green's theorem and apply to problems	Lecture	MA2109.4	
20	divergence theorem and its Examples	Understand the concept of divergence theorem and apply to problems	Lecture	MA2109.4	
21, 22, 23	Stoke's theorem and its Examples	Understand the concept of Stoke's theorem and apply to problems	Lecture	MA2109.4	
24, 25	Partial Differential Equation: Basic concepts	Understand the Basic concepts of PDE	Lecture	MA2109.3	
26	solutions of equations involving derivatives with respect to one variable only	Able to solve PDE	Lecture	MA2109.3	
27	Solutions by indicated transformations and separation of variables	Able to solve PDE	Lecture	MA2109.3	
28	One dimensional wave equation their solutions	Able to solve wave equations	Lecture	MA2109.3	
29	one dimensional heat equation and their solutions	Able to solve heat equations	Lecture	MA2109.3	
30	Introduction of OT	Basic knowledge about optimization Techniques	Lecture	MA2109.5	
31	Basic Solution and Basic Feasible Solution	able to find BS & BFS		MA2109.5	
32, 33	Simplex Method	Able to solve LPP by SM	Lecture	MA2109.5	
34	Two-Phase method	Able to solve LPP by SM and two-phase problems	Lecture	MA2109.5	
35	Transportation problems	Able to solve TP		MA2109.5	
36	Conclusion and Course Summarization	Value and analysis	Lecture	MA2109.5	

4. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
MA2109.1	Understand the periodic function and solve the problems using Fourier series and Fourier transform	3	2	2	2								2	2	3	
MA2109.2	Understand the Fourier Transforms and their applications in engineering	3	2	2	2								3		2	
MA2109.3	Ability to solve the problems using Laplace, heat and wave equations	3	3	3	2		2						2	2	2	
MA2109.4	Learn about vector calculus and their applications in engineering	3	3	3	2		2						3	2	2	
MA2109.5	Learn real life engineering problem based on LPP and Transportation problems.	3	2	2	2	2							3	2	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Analog Electronic Circuits | EC 2102 | 4 Credits | 3 1 0 4

Session: Aug. 23 – Dec. 23 | Faculty: Mr. Ashish Vijay| Class: Core Subject

A. **Introduction:** This course comes in the class of core subject for the undergraduates. This offered course covers very significant topics of electronic devices and Circuits.To impart an indepth knowledge in electronic semiconductor devices & circuits, course give importance to the various aspects of design & analysis of different amplifiers. The subject scope would help students to incorporate these concepts into their electronic designs for other courses and also with industrial applications.

B. **Course Outcomes:** At the end of the course, students will be able to

[EC2102.1]. Develop and analyse various diode and transistor applications;
[EC2102.2]. Apply biasing scheme for transistor circuits;
[EC2102.3]. Prepare BJT and FET amplifier circuits;
[EC2102.4]. Develop High and Low frequency models of Transistors and analyze for research skills.
[EC2102.5]. Understanding of devices would enhance technical as well as employability skills.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.3]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.4]. **Design/development of solutions**: Designa component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.5]. **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

[PO.6]. **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

[PO.7]. **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

[PO.8]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.9]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.10]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.11]. **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

[PO.12]. **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

[PO.13]. **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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	30
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Junction Diode Analysis: Built in voltage, Transition and diffusion capacitances. Small-Signal Operation and Models: The Collector Current, Input Resistance at the Base, at the Emitterand the Transconductance, The T and Pie model, Application of the Small-Signal Equivalent Circuits, Analysis the single stage amplifier of CE,CB and CC configurations, The BJT Internal Capacitances and High-Frequency Model, , Multistage amplifiers: Distortion in amplifiers, Frequency response of an amplifier, bandwidth of cascaded amplifiers, frequency response of an RC coupled, direct coupled and transformer coupled stages. Power amplifiers: Classification of large signal amplifiers, Analysis and design with respect to efficiency, linearity and harmonic

distortions of classes of Amplifier. Field Effect Transistor: Structure of JFET and MOSFET, device Characteristics, FET biasing, small signal, Analysis of CS, CD and CG amplifiers at low and high frequencies. Feedback amplifiers: Concept of feedback, types of feedback – their advantages and disadvantages, Determining the Loop Gain, Equivalence of Circuits from a Feedback-Loop Point of View, Effect of Feedback on the Amplifier Poles. Oscillators: Barkhausen criterion for sustained oscillation, Nyquist criterion for stability of amplifier, Types of Oscillators: Hartley and Colpitt's oscillator; Wein bridge oscillator; RC phase shift oscillator; crystal oscillator. Introduction to Power Electronic Devices

F. TEXT BOOKS

T1.J. Millman& C. C. Halkias, "Integrated Electronics", Tata McGraw Hill, New Delhi, 2011

T2. R. L. Boylestad& L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 2009

G. REFERENCE BOOKS

R1 .A. S. Sedra, K. C. Smith, *Microelectronic Circuits, Technology and System Applications*, (7e), Oxford University Press, 2014.

R2. S. Salivahanan and N Suresh Kumar, "Electronics Device and circuits", McGraw Hill Publication, 2010

H. Lecture Plan:

Lec. No.	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1,2,	Transport Phenomena in semiconductor	Students would get conceptual knowledge of the transport phenomena in the semiconductor crystal.	Lecture	NA	NA
3,4,5,6	Junction Built in potential	Knowledge of PN junction working principle.	Lecture	2102.1	In Class Quiz Mid Term-01 End Term
7,8	Transition and diffusion capacitances	Knowledge of different capacitive effects develop due to Space Charge Region	Lecture	2102.1 & 2102.2	In Home Assignment Mid Term-01 End Term
9,10,11	Transport Phenomena in BJT	Conceptual working of BJT	Lecture	2102.5	MidTerm-01 End Term
12,13	BJT Configurations	Knowledge of Different configuration of BJT	Lecture	2102.3 & 2102.4	MidTerm-02 End Term
14,15	Transistor Biasing	Requirement & Selection of Biasing circuit	Lecture	2102.3 & 2102.4	MidTerm-02 End Term
16	BJT as CE Amplifier	Understanding of Amplifying action.	Lecture	2102.1	MidTerm-02 End Term
17,18,19	Small-Signal Operation and Models	Transistor at Low Frequency-Two port analysis of CE Amplifier.	Lecture	2102.1	Mid Term-02 End Term
20,21,22	The Collector Current, Input Resistance at the Base, at the Emitterand the Transconductance	Understanding The Collector Current, Input Resistance at the Base, at the Emitterand the Transconductance	Lecture	2102.2, 2102.3 & 2102.4	In Class Quiz End Term
21,22	The T and Pie model , Application of the Small-Signal Equivalent Circuits, Analysis the single stage amplifier of CE,CB and CC configurations	Understanding CE, CB and CC amplifier using T and Pie model	Lecture	2102.2,2102.3 & 2102.4	Mid Term-02 End Term
23,24	multistage amplifiers: Distortion in amplifiers, Frequency response of an amplifier, bandwidth of cascaded amplifiers, and low frequency response of an RC coupled stage;	Understanding of cascading effect and different coupling used for coupling.	Lecture	2102.2,2102.3 & 2102.4	MidTerm-02 End Term m
25,26.27	Transistor at high frequencies: Hybrid – TT model, high frequency limitations;	Transistor at High frequency	Lecture	2102.5	Mid Term-02 End Term
28.29	CE amplifier at high frequencies	Application of pi-model in CE amplifier	Lecture	2102.1	Mid Term-02 End Term
30,31	Classification of large signal amplifiers	Understanding of Power amplifier.	Lecture	2102.2,2102.3 & 2102.4	Mid Term-02 End Term
32,33,34	Structure of JFET and MOSFET, Characteristics	FET & MOSFET working principle	Lecture	2102.1	Mid Term-02 End Term
35	FET biasing	Requirement & Selection of Biasing circuit	Lecture	2102.4 & 2102.5	Mid Term-02 End Term
36	Small signal, Analysis of CS	FET CS configuration working	Lecture	2102.2	End Term

37,38,39	Determining the Loop Gain, Equivalence of Circuits from a Feedback-Loop Point of View, Effect of Feedback on the Amplifier Poles	Circuits in a closed loop environment	Lecture	2102.5	End Term
40,41,42	Types of Oscillators	Circuits with positive feedback	Lecture	2102.4	End Term
End of the session					

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 1306.1	Develop and analyse various diode and transistor applications	1	2	3											3	
EC1306.2	Apply biasing scheme for transistor circuits;	2	1												3	
EC 1306.3	Prepare BJT and FET amplifier circuits;	1	1	3											3	
EC 1306.4	Analyse High and Low frequency models of Transistorsandanalyze for research skill	1		2	3										3	
EC 1306.5	Understanding of devices would enhance technical as well as employability skills					1								1		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Digital System Design & Computer Architecture | EC2103 | 3 Credits | 3 0 1 4

Session: July-Nov 22 | Faculty: Dr. Chusen Duari | Class: Core Course

A. **Introduction:** This offered course is designed to provide basic knowledge of Digital circuits and the principles of computer organization with their basic architecture concepts. This course will also impart the core knowledge of combination and sequential circuits which enable student to learn how the design a system can be simulated. The course emphasizes on instruction set design, assembly language programming techniques, CPU instruction sets, addressing modes, computer arithmetic, memory hierarchy, I/O systems, and multi-core/multi-processor systems

B. **Course Outcomes:** At the end of the course, students will be able to :

[EC2103.1]. Define the combinational and arithmetic circuits using logic gates.

[EC2103.2]. Describe all sequential circuits such as flip-flops, counters, shift registers.

[EC2103.3]. Implementation of finite state machine using sequential logic circuit and use Verilog HDL code for enhancing the employability skills in VLSI Domain.

[EC2103.4]. Illustrate functional units of the processor such as the registers, arithmetic logical unit, addressing modes and instructions set.

[EC2103.5]. Analyse the functionality of binary addition, subtraction, multiplication, and division using algorithms.

[EC2103.6]. Explain the organization of control unit, memory unit and the I/O unit

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge:** Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Designa component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	20
	Sessional Exam II	20
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	20
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Introduction to Combinational logic circuits. Design of arithmetic circuits: code convertors, multiplexers, demultiplexers, encoders, decoders & comparators, Parity generators and checker. Introduction to Sequential Logic: Binary cell, Latches and flip-flops. RS, JK, Master-Slave JK, D & T flip flops, Registers, Shift Registers.Sequential circuit design: Binary Counters, Finite State Machines, Moore and Mealy Machines.Overview of typical computer architecture: Accumulator based, General Register based and Stack based. Data Path and Control Unit Design: Basic concepts, Types of Bus structures, Control Unit design methods-Hardwired and micro programmed. Computer Arithmetic: Fast adders, subtractors, Multiplication of signed and unsigned integers, Booths Multiplication algorithm, Division, Floating Point Arithmetic Operation. Memory Organization: Memory hierarchies- types of ROMs, Main memory- SRAM and DRAM, Memory Address Map; Cache memory- mapping functions – associative, direct and set-associative. Sequential circuit design: Introduction to Verilog programming.

F. TEXT BOOKS

1. S. Brown and Z. Vranesic, Fundamentals of Digital logic with Verilog Design, (3e), McGraw Hill, 2014.
2. M. Mano and M. Ciletti, Digital Design: With an introduction to Verilog HDL, (5e), Pearson, 2012.
3. Z. Navabi, Verilog Digital System Design, (2e), McGraw Hill, 2008.
4. M. Morris Mano, Computer System Architecture, (3e), Pearson, 2008.

G. REFERENCE BOOKS

1. John P. Hayes, Computer Architecture and Organization, (3e), TMH, 1998.
2. 6. C. Hamacher, Z. Vranesic, S. Zaky, Computer Organization, (5e), TMH, 2002.

H. Lecture Plan:

Lec. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1,2	Introduction to Combinational logic circuits: adders & subtractors	Students will be able to design various combinational circuit and their application	Online Lecture	EC2103.1	In Class Quiz Mid Term-01 End Term
3, 4,	Design of arithmetic circuits: code convertors,	Students will be able to design various combinational circuit and their application	Online Lecture	EC2103.1	In Class Quiz Mid Term-01 End Term
5,6	Design of arithmetic circuits: multiplexers, demultiplexers,	Students will be able to design various combinational circuit and their application	Online Lecture	EC2103.1	In Class Quiz Mid Term-01 End Term
7,8	Encoders & decoders	Students will be able to design various combinational circuit and their application	Online Lecture	EC2103.1	In Class Quiz Mid Term-01 End Term
9,10	comparators & Parity generators and checker	Students will be able to design various combinational circuit and their application	Online Lecture	EC2103.1	In Class Quiz Mid Term-01 End Term
11	Introduction to Sequential Logic: Binary cell, Latches and flip-flops.	Students will learn about memory cell.	Online Lecture	EC2103.2	In Class Quiz
12,13	RS, JK, Master-Slave JK, D & T flip flops.	Students will identify various memory elements and their characteristics used in sequential circuit	Online Lecture	EC2103.2	In Class Quiz Mid Term-02 End Term
14,15	Sequential circuit design: Registers, Shift Registers,	Students will learn to design various registers and their uses	Online Lecture	EC2103.2	In Class Quiz Mid Term-02 End Term
16,17, 18	Sequential circuit design: Binary Counters,	Students will learn to design various counters and their uses.	Online Lecture	EC2103.3	In Class Quiz
19,20, 21	Finite State Machines: Moore and Mealy Machines.	Students will learn to design various finite state machines and their uses	Online Lecture	EC2103.3	In Class Quiz Mid Term-02 End Term
22,23	Overview of typical computer architecture	Students would get acquainted with basic understanding computer architecture and its developmental stages.	Online Lecture	EC2103.4	In Class Quiz Mid Term-02 End Term
24-27	Overview of typical computer architecture: Accumulator based, General Register based and Stack based.	Basic understanding of computer architecture fundamentals.	Online Lecture	EC2103.4	In Class Quiz Mid Term-02 End Term
28	Data Path and Control Unit Design: Basic concepts	Understanding of control unit design fundamentals.	Online Lecture	EC2103.4	In Class Quiz Mid Term-02 End Term

29	Types of Bus structures	Understanding of control unit design fundamentals.	Online Lecture	EC2103.4	In Class Quiz Mid Term-02
30-33	Control Unit design methods- Hardwired and micro programmed	Understanding of various micro-operations.	Online Lecture	EC2103.4	In Class Quiz Mid Term-02
34,35	Computer Arithmetic: Fast adders, subtractors	Knowledge of arithmetic operations.	Online Lecture	EC2103.5	In Class Quiz Mid Term-02 End Term
36,37, 38	Computer Arithmetic: Multiplication of signed and unsigned integers	Knowledge of arithmetic operations.	Online Lecture	EC2103.5	In Class Quiz Mid Term-02 End Term
39,40, 41	Booths Multiplication algorithm, Division	Knowledge of arithmetic operations.	Online Lecture	EC2103.5	In Class Quiz End Term
42	Floating Point Arithmetic Operation.	Understanding of floating point numbers and their fundamentals.	Online Lecture	EC2103.5	End Term
43,44	Memory Organization: Memory hierarchies- types of ROMs, Main memory- SRAM and DRAM, Memory Address Map	Basic understanding of memory mapping,	Online Lecture	EC2103.6	End Term
45,46	Cache memory-mapping functions – associative, direct and set-associative.	Knowledge of cache and its basics.	Online Lecture	EC2103.6	End Term
47,48	Introduction to Verilog programming.	Students will be familiarised with HDL language and software.	Online Lecture	EC2103.3	End Term

I. Course Outcome Attainment Level Matrix:

CO	STATEMENT	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 40%**												ATTAINMENT OF PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 2103.1	Define the combinational and arithmetic circuits using logic gates.	1	1	0	0	0	0	0	0	0	0	1	1	2	2	0
EC 2103.2	Describe all sequential circuits such as flip-flops, counters, shift registers.	3	1	1	2	2	1	2	0	0	2	2	2	3	3	1
EC 2103.3	Implementation of finite state machine using sequential logic circuit and use Verilog HDL code for enhancing the employability skills in VLSI Domain.	2	1	1	2	2	1	2	0	0	2	2	2	3	3	1
EC 2103.4	Illustrate functional units of the processor such as the registers, arithmetic logical unit, addressing modes and instructions set.	2	1	1	2	1	1	2	0	0	1	2	2	3	3	1
EC 2103.5	Analyse the functionality of binary addition, subtraction, multiplication, and division using algorithms.															
EC 2103.6	Explain the organization of control unit, memory unit and the I/O unit															

0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering

COURSE HAND OUT

Electromagnetic Field Theory | EC 2104 | 3 Credits | 3 1 0 4

Session: Aug 2022 – Nov. 2022 | **Faculty**: Dr. Abhishek Shrivastava|

Class: Core Subject; Course **for Semester**: III[rd]

A. **Introduction:** This course comes in the class of core course for the undergraduates. The course will provide basic skills, required to understand, develop, and design various engineering applications involving electromagnetic fields. The topics of the course are thoughtfully designed to lay the foundations of the application of electromagnetic fields in Antenna and Wave propagation, Transmission lines, Wireless Communications etc.

B. **Course Outcomes:** Course outcomes are goals for student learning that you, as the instructor, set for your course. Course outcomes demonstrate what you want students to know, do, or value by the end of the course. A typical course outcomes may start with - At the end of the course, students will be able to

[2104.1] Recall the fundamentals of Vector Calculus.
[2104.2] Outline the difference between Electrostatic and Magnetostatic fields using concepts and their behaviours in changed mediums.
[2104.3] Solve Electric and Magnetic fields concept related and boundary conditions problems.
[2104.4] Analyze the Electric and Magnetic field using Maxwell's Equations.
[2104.5] Estimate the phenomena of wave propagation in different media.
[2104.6] Formulate Electromagnetic Field Theory applications

C. **Program Outcomes (POs) and Program Specific Outcomes(PSOs)**

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

Program Specific Outcomes

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (probably Online/ or as per directions)	20
	Sessional Exam II (probably Online/ or as per directions)	20
	Online quizzes and Activity feedbacks (Accumulated and Averaged)	20
End Term Exam (Summative)	End Term Exam (as per directions)	40 (80 scaled down to 40)
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. (as per Academic policy 2020)	

Homework/ Home Assignment/ Activity Assignment (Tutorials) (Formative)	Student is expected to participate and perform in online assignments given via MS team with full zeal timely submission of the assignment. The participation by a student will be assessed and marks will be awarded.

E. Syllabus

Review of Vector Calculus: Cartesian coordinates, Circular, Cylindrical and Spherical co-ordinates. **Electrostatics:** Coulomb's law and its applications, Electric field intensity and Electrostatic potential due to point charges, Field due to continuous charge distribution. Electric flux and electric flux density, Gauss's law, Gauss's Law – Maxwell's equation, Electric dipole and flux lines, energy density in electrostatic fields. **Electric field in material space:** convection and conduction currents, conductors, polarization in dielectrics, continuity equation and relaxation time; **Electrostatic boundary condition:** dielectric-dielectric, dielectric-conductor. Poisson's and Laplace's equations. **Magnetostatics**: Magnetic field intensity, Biot-Savart's law, magnetic flux and magnetic flux density, Ampere's law, Maxwell's equation, application of Ampere's law, magnetic flux density- Maxwell's equation, Maxwell's equation for static fields, magnetic scalar and vector potential, magnetic boundary conditions, magnetic energy. **Electromagnetic Waves & Applications:** Maxwell's equation, Faraday's Law, transformer and motional electromotive forces, displacement current, Maxwell's equation in final form. Maxwell's equations in integral and point form for free space and material media. **Electromagnetic wave propagation**: Wave propagation in lossy dielectrics, plane waves in lossless dielectrics, plane wave in free space, plane waves in good conductors, power and the pointing vector, reflection of a plain wave in a normal incidence. **Introduction to Transmission Lines and waveguides**.

F. Reference Books

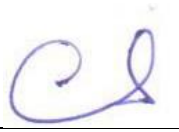
1) Jr. Hayt and Bucker, Engineering Electromagnetics, 7th Edition, McGraw Hill, 2006.
2) M. A. Plonus, Applied Electromagnetics, McGraw Hill 1978.
3) J. D. Kraus, Electromagnetics, 4th Edition, McGraw Hill 1992.
4) Cheng, Fields, Waves and Electromagnetics, 2nd Edition, Addison Wesley, 2004.
5) M. N. O. Sadiku, "Principles of Electromagnetics", 4th Ed, Oxford University Press, 2006.
6) S. Ramo, J.R. Whinnery and T. Van Duzer, Fields and Waves in Communication Electronics, Wiley, 3rd edition, 1994.
7) S.M. Wentworth, Fundamentals of Electromagnetics with Engineering Applications, Wiley, 2005.

G. E-Resources

1) www.dannex.se/theory/1.html
2) https://nptel.ac.in/courses/108/104/108104087/
3) https://nptel.ac.in/courses/115/101/115101005/

H. Lecture Plan:

Lec. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO/(s)/POs	Mode of Assessing the Outcomes
1	**Introduction** to the Course "Electromagnetic Waves"	Students would get acquainted with basic understanding of the electromagnetic waves, and its applications.	Online	NA	NA
2-4	Review of **Vector analysis:** Cartesian, Cylindrical co-ordinate systems, Spherical co-ordinate systems, Differential Length, area, and volume,	Students get acquainted with representation of point and vectors and their transformation from one coordinate system to another, and differential length, area, and volume elements in three coordinate systems	Online	2104.1/PO.1/PSO.1	In Class Quiz Mid Term-01 End Term
5-8	**Vector Calculus**: Del operator, Gradient of a scalar, Divergence of a Vector and Divergence theorem, Curl of a vector and Stokes's theorem, Laplacian of a scalar	Students can apply gradient, divergence (divergence theorem), curl (stokes theorem) and Laplacian to problems of electrostatics	Online	2104.1/ PO.1/ PSO.1	In Class Quiz Mid Term-01 End Term
9-11	**Electrostatics:** Coulomb's law and its applications, Electric field intensity and Electrostatic potential due to point charges	Students can evaluate the electric field intensity and electrostatic potential using coulomb's law for point charges.	Online	2104.2/ PO.2/ PSO.1	In Class Quiz MidTerm-01 End Term
12,13	Electric field intensity and Electrostatic potential due to line, surface, volume charge distribution.	Students can evaluate the electric field intensity and electrostatic potential using coulomb's law for charge distributions.	Online	2104.2 and / PO.2 / PSO.1	In Class Quiz MidTerm-01 End Term
14,15	Electric flux and electric flux density, Gauss's law - Maxwell's equation & its applications	Students can evaluate the electric flux and electric flux density using gauss's law for standard configurations (point charges & charge distributions).	Online	2104.2/ PO.2 / PSO.1	In Class Quiz MidTerm-01 End Term
16-17	Electric dipole and flux lines, energy density in electrostatic fields, **Electric field in material space:** convection and conduction currents, conductors, polarization in dielectrics, continuity equation and relaxation time.	Students would get acquainted with basic understanding of the concept of electric fields in materials & energy density of electrostatic field.	Online	2104.2/ PO.2/ PSO.1	In Class Quiz End Term
18-21	**Electrostatic boundary condition**: dielectric-dielectric, dielectric-conductor, Poission's and Laplace's equations.	Students understand the Laplace and Poisson's equation & can apply boundary conditions to problems of electrostatics.	Online	2104.2, 2104.3/ PO.2, PO.4 and PO.5/ PSO.1	In Class Quiz Mid Term-01 End Term

22	**Magnetostatic**s: Magnetic field intensity, Biot-Savart's law,	Students can evaluate the magnetic field intensity for a current carrying conductor using Biot-Savart law.	Online	2104.2/ PO.2/ PSO.1	In Class Quiz MidTerm-02 End Term
23-25	Magnetic flux and magnetic flux density, Ampere's law (Maxwell's equation) & its application	Students can evaluate the magnetic field intensity for standard current distributions using Ampere's law.	Online	2104.4/ PO.2/ PSO.1	In Class Quiz MidTerm-02 End Term
26,27	**Maxwell's equation** for static fields, magnetic scalar, and vector potential,	Students would be able to understand the Maxwell's equations and their significance, and compute magnetic scalar and vector potential.	Online	2104.2, 2104.4/ PO.2 / PSO.1	In Class Quiz MidTerm-02 End Term
28	Magnetic boundary conditions, magnetic energy;	Students can apply magnetic boundary conditions to problems of magnetostatics and have a basic understanding of concept of magnetic energy.	Online	2104.3/ PO.2/ PSO.1	In Class Quiz MidTerm-02 End Term
29-32	**Electromagnetic Waves & Applications**: Maxwell's equation, Faraday's Law, transformer and motional electromotive forces, displacement current.	Students understand Faraday's law and the connection between electric and magnetic fields, and the concept of transformer, EMF, and displacement current.	Online	2104.5/ PO.2/ PSO.1	In Class Quiz MidTerm-02 End Term
33,34	Maxwell's equation in final form, Maxwell's equations in integral and point form for free space and material media.	Students would be able to understand the Maxwell's equations for free space & material media and their significance.	Online	2104.4,2014.5/ PO.2 & PO.3/ PSO.1	MidTerm-02 End Term
35,36	**Electromagnetic wave propagation**: Wave propagation in lossy dielectrics, plane waves in lossless dielectrics,	Students can understand and analyse the wave propagation phenomenon in lossy and lossless dielectrics.	Online	2104.5/PO.4/ PSO.1	End Term
37,38	Plane wave in free space, plane waves in good conductors,	Students can understand and analyse the wave propagation phenomenon in free space and good conductors.	Online	2104.5/PO.4/ PSO.1 and PSO.2	In Class Quiz End Term
39	Power and the pointing vector	Students can compute the power using pointing vector theorem.	Online	2104.5/PO.4	In Class Quiz End Term
39,40	reflection of a plane wave in a normal incidence.	Students can analyse the reflection of a plane wave in a normal incidence.	Online	2104.5/PO.4 and PO.5/ PSO.1 and PSO.2	In Class Quiz End Term
41	Introduction to Transmission Lines and waveguides.	Students can understand basics of transmission lines and waveguides.	Online	2104.6/PO.3, PO.4 and PO.5/ PSO.1 and PSO.2	In Class Quiz End Term 

42	Course Summary and Conclusion	Students are familiar with the applications of electromagnetics.	Online	NA	NA

I. Course Articulation Matrix: (Mapping of COs with POs)

Course Outcomes (Cos)	Statements	Correlation with Program Outcomes (POs)												Correlation with Program Specific Outcomes (PSOs)		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 2104.1	Recall the fundamentals of Vector Calculus.	3	1											2		
EC 2104.2	Outline the difference between Electrostatic and Magnetostatic fields using concepts and their behaviours in changed mediums.	1	3	2	1	1								2		
EC 2104.3	Solve Electric and Magnetic fields concept related and boundary conditions problems.	1	3	2	1	1								2		
EC 2104.4	Analyze the Electric and Magnetic field using Maxwell's Equations.	3	3	2										2	1	
EC 2104.5	Estimate the phenomena of wave propagation in different media.		2	1	1	1								2	1	
EC 2104.6	Formulate Electromagnetic Field Theory applications.			2	1	1										

1. Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Dr. Abhishek Shrivastava

Course Coordinator

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Analog Electronics Lab| EC2130| 1 Credits | 0 0 2 1

Session: Aug 23 – Dec 23 | Faculty: Dr Neha Singh | Class: III sem Lab course

A. **Introduction:** This course is offered by Dept. of Electronics & Communication Engineering as a Lab course in III semester with theory course EC2102 Analog Electronics. This course aims to help the students understand practical use and implementation of the theoretical concepts of semiconductor devices and circuits. The students are exposed to different analog electronic components and circuits, their practical feasibility, capability and limitations regarding their best utilization in a specific situation. The course emphasizes circuit design and analysis skills that require the student to create and analyse circuits that meet customer/user specifications as industry professional or entrepreneur. In addition to hands-on practice for circuit assembly and observation of output, the lab uses Virtual Lab (IIT Kharagpur) and Multisim software to make students aware of the use of software for circuit simulation which will be helpful for projects later.

B. **Course Outcomes:** At the end of the course, students will be able to

[EC2130.1]. Understand semiconductor device characteristics
[EC2130.2]. Analyze device characteristics to determine important device and circuit parameters
[EC2130.3]. Implement circuits with diodes
[EC2130.4]. Implement circuits with BJT and FET
[EC2130.5]. Understand the effect of input frequency on amplifier circuits

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Each lab experiment is evaluated for performance, lab record maintenance and knowledge and viva during the entire semester. The score is scaled to a maximum of **60 marks**.	60
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Lab sessions (Formative)	A student who misses a class will have to report to the teacher about the absence. He/ She has to perform the experiment issued on the missed date in extra time during the same week. If the student fails to carry out the experiment in the same week, he will be marked absent with zero marks for attendance in evaluation.	
Lab record	The students need to maintain lab-records of the experiment they carry out in the lab. It is expected from the student that he completes the experiment details in the record within the week of issue of the experiment and get it corrected in the next lab-class itself. Delay in submission of work will attract penalty of marks. A separate Lab-notebooks is to be maintained by individual student to take down observations during lab. The students should get their observations approved by faculty.	

E. SYLLABUS

Experiments of this lab are implemented at Hardware as well as software level.

- Device characteristics of BJT and JFET
- Applications of diode: clippers and clampers
- Applications of BJT and FET: amplifiers with feedback and without feedback, single and two stage RC coupled amplifiers and Oscillators.

F. TEXT BOOKS

Not Applicable

G. REFERENCE BOOKS

[1] R. L. Boylestad & L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 2009
[2] S. Salivahanan and N. Suresh Kumar, "Electronics Device and circuits", McGraw Hill Publication, 2010

H. Lecture Plan:

Lab No.	Name of the experiment	Experiment Outcome	Type of Expt	Corresponding CO	Mode of Assessing the Outcome
1	Generation and measurement of the DC voltage and AC signals.	To acquaint students with laboratory equipment and take readings	Hands-on	NA	NA
2	To plot the diode characteristics and find its dynamic resistance & cut-in voltage.	To understand working of pn diodes	Hands-on	EC2130.1 EC2130.2	Observational Data, Viva-Voce
3	To implement a diode clipper circuit and observe its output waveform.	To analyze use of pn diodes for waveshaping circuits	Hands-on	EC2130.3	Observational Data, Viva-Voce
4	To implement a diode clamper circuit which clamps the positive and negative peak of input voltage to (a) Zero voltage and (b) at a given voltage.	To analyze use of pn diodes for waveshaping circuits	Software	EC2130.3	Observational Data, Viva-Voce
5	To plot the characteristics of Zener diode and find its dynamic resistance under reverse biased condition.	To understand working of zener diodes	Hands-on	EC2130.1 EC2130.2	Observational Data, Viva-Voce
6	To use Zener diode for voltage regulation (i) Plot the Line-Regulation curve and (ii) Plot the Load-Regulation curve.	To analyze use of Zener diodes for regulation	Software	EC2130.3	Observational Data, Viva-Voce
7	(a) To plot the input and output characteristics of NPN transistor in CE configuration. (b) To find the h-parameters of the transistor from its characteristics.	To understand working of BJT and obtain its parameters from the characteristic curves	Virtual Lab	EC2130.1 EC2130.2	Observational Data, Viva-Voce
8	To plot the frequency response of a single stage RC coupled CE amplifier and determine its bandwidth.	To analyze application of BJT for amplification	Software	EC2130.4 EC2130.5	Observational Data, Viva-Voce
9	To find the bandwidth of emitter follower circuit.	To analyze application of BJT for amplification	Hands-on	EC2130.4 EC2130.5	Observational Data, Viva-Voce
10	To observe the effect of negative feedback (Emitter bypass capacitors) on the frequency response of an amplifier.	To understand the effect of negative feedback	Software	EC2130.2 EC2130.4	Observational Data, Viva-Voce
11	(a) To plot the drain and transfer characteristics of a JFET in CS configuration. (b) To find the pinch-off voltage, maximum drain to source saturation current and transconductance of a JFET.	To understand working of FET and obtain its parameters from the characteristic curves	Virtual Lab	EC2130.1 EC2130.2	Observational Data, Viva-Voce
12	To plot the frequency response of a Common Source (CS) Amplifier.	To analyze application of FET for amplification	Hands-on	EC2130.4 EC2130.5	Observational Data, Viva-Voce

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC2130.1].	Understand semiconductor device characteristics	1											1	1		
[EC2130.2].	Analyze device characteristics to determine important device and circuit parameters		1		1	3							1	2		
[EC2130.3].	Implement circuits with diodes		2	1	2	3			1	1			1	1	2	1
[EC2130.4].	Implement circuits with BJT and FET		2	1	2	3			1	1			1	1	2	1
[EC2130.5].	Understand the effect of input frequency on amplifier circuits	1	1						1	1	1		1	1		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Dr Neha Singh

Course co-ordinator & Instructor

Class Representative

HoD (ECE)

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

DSD & HDL Lab | EC2131 | Credits | 0 0 2 1

Session: July-Nov 23 | Faculty: Dr. Chusen Duari | Class: Lab Course

A. **Introduction:** This course is offered by Dept. of Electronics & Communication Engineering as a Lab course in III semester with theory course EC2103, Digital System Design & Computer Architecture. This offered course is designed to provide experimental platform to students to get hands on experience various Digital circuits design with the help of Integrated circuits and also facilitate students to get experience on RTL level design and verification using Verilog language with EDA tools. Students will design and implement various combinational and sequential circuits starting from gate level to high-level modules such as adders, decoders, multiplexer, Flip flop, counter, register etc. The course also emphasizes circuit design and analysis skills that require the student to create circuits that meet customer/user specifications as industry professional or entrepreneur. The prerequisite for this lab is a complete understanding of digital electronics.

B. **Course Outcomes:** At the end of the course, students will be able to :

- **[EC2131.1].** Understand the basic Concept of logic design with the help of breadboard and various logic gates.
- **[EC2131.2].** Implement various combinational circuit with logic gates as well as ICs.
- **[EC2131.3].** Implement various sequential circuit with logic gates as well as ICs.
- **[EC2131.4].** Implement and verify the various combinational and sequential circuits with Verilog Hardware Description language using EDA tool.
- **[EC2131.5].** Apply the concept of Digital Design to implement complex sequential circuit and use Verilog HDL code for enhancing the employability skills in VLSI Domain

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

- **[PO.1].** **Engineering knowledge:** Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.
- **[PO.2].** **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **[PO.3].** **Design/development of solutions**: Designa component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- **[PO.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
- **[PO.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
- **[PO.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
- **[PO.7].** **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
- **[PO.8].** **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

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[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Each lab experiment is evaluated for performance, lab record maintenance and knowledge and viva during the entire semester. The score is scaled to a maximum of **60 marks**.	60
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Lab sessions (Formative)	A student who misses a class will have to report to the teacher about the absence. He/ She has to perform the experiment issued on the missed date in extra time during the same week. If the student fails to carry out the experiment in the same week, he will be marked absent with zero marks for attendance in evaluation.	
Lab record	The students need to maintain lab-records of the experiment they carry out in the lab. It is expected from the student that he completes the experiment details in the record within the week of issue of the experiment and get it corrected in the next lab-class itself. Delay in submission of work will attract penalty of marks. A separate Lab-notebooks is to be maintained by individual student to take down observations during lab. The students should get their observations approved by faculty.	

E. SYLLABUS

EC2131: DSD & HDL LAB [0 0 2 1]

Experiments of this lab are implemented at Hardware as well as software level. List of experiments include: Study of Implementation techniques of combinational circuits, Implementation of Arithmetic circuits using logic gates and MSI chips, Building circuits using MSI chips and their applications, Designing of sequential circuits, Implementation of FSMs, Design of Asynchronous sequential circuits, Design of Combinational & Sequential Circuits using HDL

F. TEXT BOOKS

1. S. Brown and Z. Vranesic, Fundamentals of Digital logic with Verilog Design, (3e), McGraw Hill, 2014.
2. M. Mano and M. Ciletti, Digital Design: With an introduction to Verilog HDL, (5e), Pearson, 2012.
3. Z. Navabi, Verilog Digital System Design, (2e), McGraw Hill, 2008.

G. REFERENCE BOOKS

1. Advanced Digital Design with the Verilog HDL, 2/e Paperback – 1 March 2017
by D. Ciletti Micahel

H. List of Experiments:

Lab No.	Name of the experiment	Experiment Outcome	Type of Expt	Corresponding CO	Mode of Assessing the Outcome
1	Introducton to Digital Trainer kit, breadboard and Integrated circuit	To acquaint students with laboratory equipment and take readings	Hands-on	EC2131.1	NA
2	Verification of truth table for (a) Digital logic gates (AND, OR,NOT, NAND, NOR, XOR) (b) AND & OR using universal gate	To understand the pin configuration and use of ICs	Hands-on	EC2131.1	Observational Data, Viva-Voce
3	Implementation of (a) Half Adder & Full Adder (b) Half Subtractor & Full Subtractor using logic gates.	To understand working of arithmetic circuits	Hands-on	EC2131.2	Observational Data, Viva-Voce
4	Design & Implementation of (a) Multiplexer & Demultiplexer. (b) Decoder & Encoder	To understand working of data handling circuits	Hands-on	EC2131.2	Observational Data, Viva-Voce
5	(a) Introduction to Xilinx vivado EDA tool. (b) Implementation and verification of various logic gates using verilog HDL.	To understand the RTL coding in Verilog language	Hands-on	EC2131.4	Observational Data, Viva-Voce
6	Implementation & simulation of (a) Half Adder & Full Adder (b) Half Subtractor & Full Subtractor using Xilinx Vivado.	To understand the RTL coding in Verilog language	Hands-on	EC2131.4	Observational Data, Viva-Voce
7	Implementation of (a) Multiplexer, (b) Decoder (c) N-bit comparator using Xilinx Vivado.	To understand the RTL coding in Verilog language	Hands-on	EC2131.4	Observational Data, Viva-Voce
8	Design & verify the output waveform for (a) Binary to gray code converter. (b) BCD to xcess-3 code converter using Xilinx Vivado.	To understand the RTL coding in Verilog language	Hands-on	EC2131.4	Observational Data, Viva-Voce
9	Implementation and verification of truthtables for SR, JK, T and D flip flops using gates.	To analyze application of basic gates to realize sequential blocks	Hands-on	EC2130.3	Observational Data, Viva-Voce
10	Realization of Flipflops with verilog HDL for edge and level triggering using Xilinx Vivado.	To understand the behavioral description of clock driven circuit in Verilog language	Hands-on	EC2130.4	Observational Data, Viva-Voce

11	Implementation and verification of SISO and SIPO registers.	To analyze application of basic gates to realize sequential blocks	Hands-on	EC2130.5	Observational Data, Viva-Voce
12	Design and verify the state table of Asynchronous & Synchronous up/down counter.	To understand the behavioral description of clock driven circuit in Verilog language	Hands-on	EC2130.5	Observational Data, Viva-Voce
13	Design & Simulate Full adder and Higher order Mux using structural coding with Xilinx Vivado	To understand the structural description of complex circuit with simpler module	Hands-on	EC2130.4	Observational Data, Viva-Voce

I. Course Outcome Attainment Level Matrix:

CO	STATEMENT	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 40%**												ATTAINMENT OF PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 2131.1	Understand the basic Concept of logic design with the help of breadboard and various logic gates.	1	1	0	0	0	0	0	0	0	0	1	1	2	2	0
EC 2131.2	Implement various combinational circuit with logic gates as well as ICs.	3	1	1	2	2	1	2	0	0	2	2	2	3	3	1
EC 2131.3	Implement various sequential circuit with logic gates as well as ICs.	2	1	1	2	2	1	2	0	0	2	2	2	3	3	1
EC 2131.4	Implement and verify the various combinational and sequential circuits with Verilog Hardware Description language using EDA tool.	2	1	1	2	1	1	2	0	0	1	2	2	3	3	1
EC 2131.5	Apply the concept of Digital Design to implement complex sequential circuit and use Verilog HDL code for enhancing the employability skills in VLSI Domain	1	1					1	1	1		1				

0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment

MANIPAL UNIVERSITY JAIPUR

SCHOOL OF ELECTRICAL, ELECTRONICS & COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Course Hand-out

PROJECT BASED LAB – I EC2170| 1 Credits | 0 0 2 1

Session: Aug. 23 – Nov. 23 | Faculty: Dr. Abhishek Shrivastava & Dr. Rohit Mathur|

Class: Project Lab | Mode of Academic delivery: Physical and online both|

A. Introduction: This course will be conducted largely as an individual or small group project under the direct supervision of a member of academic staff. The specific project topic undertaken will reflect the common interests and expertise of the student(s) and supervisor. Students will be required to:

1- Perform a literature search to review current knowledge and developments in the chosen technical area;
2- Undertake detailed technical work in the chosen area using one or more of:
   Theoretical studies
   Computer simulations
   Hardware construction;
3- Produce progress reports or maintain a professional journal to establish work completed, and to schedule additional work within the time frame specified for the project;
4- Deliver a seminar on the general area of work being undertaken and specific contributions to that field;
5- Prepare a formal report describing the work undertaken and results obtained so far; and
6- Present the work in a forum involving poster presentations and demonstrations of operational hardware and software.

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

[EC2170.1] Demonstrate a sound technical knowledge of their selected project topic.
[EC2170.2] Undertake problem identification, formulation and solution.
[EC2170.3] Able to analyse the circuit and troubleshoot errors if any.
[EC2170.4] Demonstrate the knowledge, skills and attitudes of a professional engineer to enhance employability skills.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

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[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Project Synopsis submission and its presentation (individual or Group wise)	20
	Progress Report (individual or Group wise)	20
	CWS	20
End Term Exam (Summative)	Final Seminar (as per directions) and Report	40 (80 scaled down to 40)
	Total	100
~~Attendance (Formative)~~	~~A minimum of 60% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.~~ (as per existing Academic policy)	

Homework/ Home Assignment/ Activity Assignment (Formative)	Student is expected to participate and perform in physical mode or via online progress seminar given via MS team with full zeal timely submission of the progress report. The participation by a student will be assessed and marks will be awarded.

E. SYLLABUS

Project-based learning is acquiring practical knowledge through experimental setup, this experimentation induces a desire to learn in newly inducted students and influences their minds to understand the applied content. The projects that may be undertaken in Project Based Lab – I include Thermostat for fridge, LED Based Emergency Lamp, Audio controlled running lights, Digital Modern LED Voltmeter, Digital Memory for Door Bell, Hard Disk Reading and writing process, Faraday Cage, Faraday's Guitar, Traffic Light Controller, 4-bit Arithmetic and Logic Unit, etc

F. Text Book :

G. References :

H. Lecture Plan:

Lecture no.	Topics for Discussion	Session Outcome	Mode of delivery	**Corresponding CO**	**Mode of Assessing the Outcome**
1,2,3	Finalization of Project topic after chosen project circuit detailed discussion		Physical/Online	EC2270.1	Project Synopsis submission and its presentation
4,5	Preparation of Synopsis		Physical/Online	EC2270.1 and EC 2270.2	Project Synopsis submission and its presentation
6,7,8,9,10	Project development stages: discussion related to queries		Physical/Online	EC2270.1, EC 2270.2 and EC2270.3	Troubleshooting
11,12,	Project simulation and hardware development plus testing on bread board		Physical/Online	EC2270.1, EC 2270.2, EC 2270.3 and EC2270.4	Report submission and evaluation
13,14	Final project submission and viva		Physical/Online	EC2270.1, EC 2270.2, EC 2270.3 and EC2270.4	Project viva presentation

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC2270.1	Demonstrate a sound technical knowledge of their selected project topic.	3	1		1		1						1	1	1	3
EC2270.2	Undertake problem identification, formulation and solution.	3	1	2										3	2	2
EC2270.3	Able to analyse the circuit and troubleshoot errors if any.	3		2	2									1		3
EC2270.4	Demonstrate the knowledge, skills and attitudes of a professional engineer to enhance employability skills.	3	2		2									1		3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Dr. Abhishek Shrivastava

Course Coordinator

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Antennas | EC3101 | 4 Credits | 3 1 0 4

Session: Aug. 2023 – Dec 2023 | Faculty: Dr. Dinesh Yadav | Class: Core Course

A. Introduction: This course is offered by Dept. Electronics and Communication Engineering as a Core Course, targeting students who wish to pursue a career in the field of Antenna Engineering, including designing antennas for various applications and analysing the performance in free space.

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

[EC3101.1] Explain radiation phenomena and need of antenna theory for wireless applications to promote sustainable development in RF field.
[EC3101.2] Define and understand fundamental antenna parameters.
[EC3101.3] Analyse radiation characteristics and designing techniques of different antenna structures and hence develop employability skills.
[EC3101.4] Illustrate techniques for antenna parameter measurements.
[EC3101.5] Understand the propagation of electromagnetic waves in different propagation modes.
[EC3101.6] Recognize the effect involved in free space propagation.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge:** Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions:** Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.5]. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

[PO.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

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[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam (1hr. 30 Min)	30
	Quizzes and assignments Weekly/ bi-monthly Online Course Research Paper Review Research Project Semester-long Hackathon MOOC courses on the SWAYAM/NPTEL In class Quizzes, courses (online or offline), platforms (with passing certificate), long term hackathons, Activity feedback (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ / Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

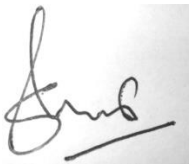
Introduction: Radiation Mechanism, current distribution, Antenna parameters; Vector potentials: Electric and magnetic vector potentials, solutions for wave equations, far-field radiation, Duality theorem, Reciprocity theorem; Linear wire Antennas: Infinitesimal, small and finite dipole Antennas, Region separation, Half wave length dipole; Loop Antennas: Small circular loop Antenna, circular loop with constant current, Ferrite loop; Antenna Arrays and other types of antennas: Two element array, N-element array – uniform, broadside, ordinary end-fire, Non-uniform Amplitude Arrays, planar and circular arrays; Qualitative study of Folded dipole, long wire, V, Rhombic, Helical, Yagi Uda, log-periodic, Aperture antennas, and horn Antennas, Babinet's principle, Huygens's principle, Rectangular and Circular Microstrip Patch antenna, Quality Factor, Bandwidth, Efficiency; Antenna Measurements: Radiation Pattern measurement, Distance requirement for uniform phase, uniform field amplitude requirement, Introduction to phase measurement; Gain Measurement: Comparison method, Near field method, Introduction to current distribution measurement, Measurement of antenna efficiency, measurement of Noise figure and noise temperature of an antenna polarization measurement; Propagation of EM waves: Ground wave Propagation, Space Wave Propagation, Troposphere and ionosphere propagation and its effect on Radio Waves.

F. TEXT BOOKS

1. *C. A. Balanis, "Antenna Theory" 3e, John Wiley & Sons, New Delhi, 2010*
2. *K. D. Prasad "Antenna and Wave Propagation", 3E, Satya Prakashan, New Delhi, 2009*

G. REFERENCE BOOKS

1. *J. Kraus "Antenna and wave Propagation", 4e, Tata McGraw – Hill, New Delhi, 2010*
2. *F. E. Termen "Radio Engineering" Tata McGraw – Hill, New Delhi, 1995*

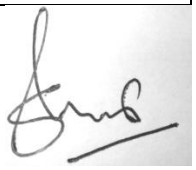


H. Lecture Plan:

Lec No	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Introduction: Types of Antennas, Radiation Mechanism, current distribution;,	Describes basics radiation mechanism of antenna radiation	Lecture	EC3101.1	In Class Quiz
3	Vector potentials: Electric and magnetic vector potentials,	Understanding of electric and magnetic potentials	Lecture	EC3101.1	In Class Quiz
4	Solutions for wave equations	Understanding of wave equation of EM radiation	Lecture	EC3101.1	In Class Quiz End Term
5	Near field far-field radiation,	Describes various radiating fields	Lecture	EC3101.1	In Class Quiz
6	Duality theorem, Reciprocity theorem;	Understanding of theorems applicable to antenna system	Lecture	EC3101.1	Class Quiz Mid Term I End Term
7-8	Antenna Parameters	Define & derive expressions for key parameters of antenna	Lecture	EC3101.2	Class Quiz Mid Term I End Term
9	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.1 & EC31012	Class Quiz
10	Linear wire Antennas: Infinitesimal, small and finite dipole Antennas,	Describes wire antennas and its type	Lecture	EC3101.3	Class Quiz Mid Term I End Term
11	Region separation, Half wave length dipole,	Describes wavelength dependent antennas	Lecture	EC3101.3	Class Quiz Mid Term I End Term
12	Image theory, vertical and horizontal antenna on perfect conductor, effect of earth curvature	Understanding of antenna orientation and external effects on radiation	Lecture	EC3101.3	Class Quiz Mid Term I End Term
13	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.3	Class Quiz
14	Loop Antennas: Small circular loop Antenna	Understanding loop antenna's radiation	Lecture	EC3101.3	Class Quiz Mid Term II End Term
15	Circular loop with constant current, Ferrite loop;	Describes various loop antennas and their applications	Lecture	EC3101.3	Class Quiz Mid Term II End Term
16	Arrays and other types of antennas: Two element array	Describes the need of Array and its advantages	Lecture	EC3101.3	Class Quiz
17	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.3	Class Quiz

18	N-element array – uniform, broadside,	Describes various types of antenna arrays	Lecture	EC3101.3	Class Quiz
19	ordinary end-fire, Non-uniform Amplitude Arrays	Describes various types of antenna arrays and their applications	Lecture	EC3101.3	Class Quiz Mid Term II End Term
20	planar and circular arrays,	Describes various types of antenna arrays and their applications	Lecture	EC3101.3	Class Quiz Mid Term II End Term
21	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.3	Class Quiz
22	Qualitative study of Folded dipole	Describes the advantages of folded dipole over dipole	Lecture	EC3101.3	Class Quiz Mid Term II End Term
23	Long wire antenna	Understanding of long wire antennas and their applications	Lecture	EC3101.3	Class Quiz
24	V, Rhombic,	Understanding of various types of extended long wire antennas	Lecture	EC3101.3	Class Quiz
25	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.3	Class Quiz
26	Helical Antenna	Understanding of radiation in helical antenna	Lecture	EC3101.3	Mid Term II End Term
27	Yagi-UDA	Understanding of radiation in Yagi-UDA antenna	Lecture	EC3101.3	Class Quiz Mid Term II End Term
28	Log-periodic,	Understanding of of radiation in log periodic antenna	Lecture	EC3101.3	Class Quiz Mid Term II End Term
29	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.3	Class Quiz
30	Aperture Antennas	Understanding of radiation in aperture antenna	Lecture	EC3101.3	Mid Term II End Term
31	Horn Antennas	Describes the radiation in horn antenna and its types	Lecture	EC3101.3	Mid Term II End Term
32	Babinet‘s principle.	Understanding of babinet’s principle.	Lecture	EC3101.3	Mid Term II End Term
33	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.3	Class Quiz
34	Huygens‘s principle	Understanding of Huygens’s principle in aperture antennas	Lecture	EC3101.3	Class Quiz End Term
35	Micro Strip Antenna: Rectangular and Circular Patch,	Describes the radiation in patch antenna and its types	Lecture	EC3101.3	Mid Term II End Term
36	Antenna Measurement	Understanding of antenna measurement techniques	Lecture	EC3101.4	Class Quiz Mid Term II End Term

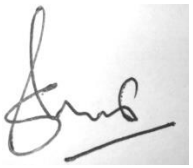
37	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.4	Class Quiz
38	Antenna Measurement Quality Factor, Bandwidth, Efficiency;	Understanding of measurement of antenna parameters	Lecture	EC3101.4	Mid Term II End Term
39	Propagation of EM waves	Describes the wave propagation in different medium	Lecture	EC3101.5	Mid Term II End Term
40	Ground wave Propagation,	Understanding of ground wave propagation	Lecture	EC3101.5	Mid Term II End Term
41	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.5	Class Quiz
42	Sky Wave Propagation	Understanding of sky wave propagation	Lecture	EC3101.5	Mid Term II End Term
43	Space Wave Propagation	Understanding of space wave propagation	Lecture	EC3101.5	Mid Term II End Term
44	Troposphere and structure of ionosphere	Understanding of structure of ionosphere	Lecture	EC3101.5	Class Quiz Mid Term II End Term
45	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.5	Class Quiz
46	Ionosphere propagation and its effect on Radio Waves	Understanding of ionosphere propagation	Lecture	EC3101.5	Mid Term II End Term
47	Ionosphere Layers	Describes various ionosphere layers	Lecture	EC3101.5	Mid Term II End Term
48	Virtual Height	Understanding of free space parameters	Lecture	EC3101.6	Mid Term II End Term
49	Maximum usable Frequency	Understanding of free space parameters	Lecture	EC3101.6	Class Quiz End Term
50	Critical Frequency	Understanding of free space parameters	Lecture	EC3101.6	Class Quiz End Term
51	Refractive Index Ionosphere	Understanding of free space parameters	Lecture	EC3101.6	Class Quiz End Term
52	Tutorial	Understanding of numerical problem solving	Question Sheet	EC3101.6	Class Quiz
53	Effect of Earth Curvature	Understanding of earth's surface in wave propagation	Lecture	EC3101.6	Class Quiz End Term
54	Ground Effects and Fading	Understanding of earth's surface in wave propagation	Lecture	EC3101.6	Class Quiz End Term



I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 3101.1	Explain radiation phenomena and need of antenna theory for wireless applications to promote sustainable development in RF field.	2	2	0	0	0	0	0	0	0	0	0	3	2	1	2
EC 3101.2	Define and understand fundamental antenna parameters.	2	1	2	1	1	0	0	0	0	0	0	2	3	3	2
EC 3101.3	Analyse radiation characteristics and designing techniques of different antenna structures and hence develop employability skills.	1	2	2	1	1	0	0	0	0	0	0	2	3	3	2
EC 3101.4	Illustrate techniques for antenna parameter measurements.	1	1	1	1	1	0	0	0	0	0	0	2	2	3	2
EC 3101.5	Understand the propagation of electromagnetic waves in different propagation modes.	2	2	2	2	1	0	0	0	0	0	0	2	2	3	2
EC 3101.6	Recognize the effect involved in free space propagation.	2	2	2	2	1	0	1	0	0	0	0	2	2	3	2
	Maximum Correlation	2	2	2	2	1	-	1	-	-	-	-	3	3	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Analog & Digital Communication | EC 3103 | 4 Credits | 3 1 0 4

Session: July 23 – December 23| Faculty: Madhuri Sahal | Class: Core

A. Introduction:

This course offers a detailed impression to the basic principles and techniques used in analog and digital communications. The course presents analog and digital modulation methods, communication transmitter and receiver, baseband and bandpass communication techniques, and noise analysis. The course also introduces logical techniques to assess the performance of communication systems.

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

[EC 3103.1] Demonstrate the use of Fourier transform to represent amplitude modulation scheme in time and frequency domain (Application)

[EC 3103.2] Compute various parameters & compare different angle modulation schemes in time and frequency domain (Analysis)

[EC 3103.3] Demonstrate use of sampling theorem for baseband signals to mitigate aliasing (Application)

[EC 3103.4] Analyse baseband communication techniques in time domain (Analysis)

[EC 3103.5] Represent baseband pulse signals into signals using appropriate line coding technique (Comprehension)

[EC 3103.6] Construct source codes and/or channel codes (create)

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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.

[PO.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.

[PO.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.

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.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.

[PO.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.

[PO.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.

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam	30
	Online quizzes and Activity feedbacks (Accumulated and Averaged)	30

End Term Exam (Summative)	End Term Exam (as per directions)	40 (80 scaled down to 40)
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. (as per Academic policy 2020)	
Homework/ Home Assignment/ Activity Assignment (Tutorials) (Formative)	Student is expected to participate and perform in online assignments given via MS team with full zeal timely submission of the assignment. There are situations where a student may have to work in home, for instance before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Introduction to Analog Communication:

EC3103: Analog & Digital Communication [3 1 0 4]

Elements of Communication systems, Analog communication techniques: Amplitude modulation schemes, Frequency Modulation, Phase Modulation, Representation of Band Pass signals and systems Relationship between PM& FM, Introduction to noise theory, Pulse modulation, Introduction to Digital Communication, Line coding, Review of Sampling theorem, Pulse code modulation (PCM), Destination SNR in PCM systems with noise, DM, ADM, Baseband data transmission, Digital modulation schemes, Coherent Binary Schemes, Coherent M-ary Schemes, source and channel encoding techniques, Applications: wireless sensor networks, spread spectrum & mobile communication, basic principles of digital TV broadcasting.

F. TEXT BOOKS

1. Simon Haykin, Communication Systems, (4e), John Wiley, 2009.

G. REFERENCE BOOKS

1. B. P. Lathi & Z. Ding, Modern Digital and Analog Communication Systems, Oxford, 2010.
2. Taub & Schilling, Principles of Communication Systems, (3e), McGraw Hill, 2008.
3. G. Kennedy, Electronic Communication Systems, (4e), McGraw-Hill, 2008.
4. John G Proakis, M.Salehi and G.Bauch, Modern Communication System Using MATLAB, (3e), Cengage Learning, 2013.
5. R.P.Singh & S.D. Sapre, Communication System-Analog and Digital, (2e), McGraw Hill, 2007.
6. D. Roddy & J. Coolen, Electronic Communications, Fourth Edition, PHI 2001.
7. H.P. Hsu, Analog and Digital Communications, Schaum's outline series TMH 2006.

Lecture Plan:

Lecture No.	Topic	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome

1.	Introduction to course & Communication Systems	Flipped Classroom	EC3103.1	Assignment/Quiz/Mid-term
2.	Review of Fourier Transform	Lecture	EC3103.1	Assignment/Quiz/Mid-term
3.	Spectral analysis	Lecture	EC3103.1	Assignment/Quiz/Mid-term
4.	Tutorial			
5.	Introduction to Analog Communication	Lecture	EC3103.1	Assignment/Quiz/Mid-term
6.	Amplitude modulation: General Equation of single tone AM	Lecture	EC3103.1	Assignment/Quiz/Mid-term
7.	Amplitude modulation: Representation of Band Pass signals (Time and Frequency domain analysis of single tone AM)	Lecture	EC3103.1	Assignment/Quiz/Mid-term
8.	Tutorial			
9.	Amplitude modulation: Generation (Square Law Modulator) & Detection (Square Law De-Modulator & Envelope Detector) of single tone AM	Lecture	EC3103.1	Assignment/Quiz/Mid-term
10.	Time and Frequency domain analysis of Multi tone AM	Flipped Classroom	EC3103.1	Assignment/Quiz/Mid-term
11.	DSB-SC, SSB, VSB & Frequency Division Multiplexing (FDM)	Lecture	EC3103.1	Assignment/Quiz/Mid-term
12.	Introduction Angle modulation (PM & FM)	Lecture	EC3103.2	Assignment/Quiz/Mid-term
13.	Tutorial			
14.	Angle modulation: General Equation of single tone NBFM & WBFM	Lecture	EC3103.2	Assignment/Quiz/Mid-term
15.	Angle modulation: Representation of Band Pass signals (Time and Frequency domain analysis of single tone FM)	Lecture	EC3103.2	Assignment/Quiz/Mid-term
16.	Calculation of modulation index for NBFM, average power for FM, transmission bandwidth	Lecture	EC3103.2	Assignment/Quiz/Mid-term
17.	Tutorial			
18-19	Generation of single tone FM	Lecture	EC3103.2	Assignment/Quiz/Mid-term
20-21	Detection of single tone FM	Lecture	EC3103.2	Assignment/Quiz/Mid-term
22	Systems Relationship between PM & FM	Lecture	EC3103.2	Assignment/Quiz/Mid-term
23	Angle modulation: Representation of Band Pass	Lecture	EC3103.2	Assignment/Quiz/Mid-term

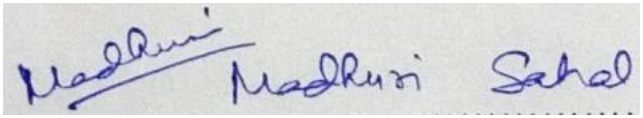
	signals (Time and Frequency domain analysis of single tone PM)			
24	Tutorial			
26	Radio Receivers	Lecture	EC3103.2	Assignment/Quiz/Mid-term
27	Superheterodyne Receiver	Lecture	EC3103.2	Assignment/Quiz/Mid-term
28.	Noise Theory: Thermal Noise, Shot Noise Signal to Noise ratio	Lecture	EC3103.2	Assignment/Quiz/Mid-term
29.	Introduction to Digital Communication System,	Lecture	EC3103.3	Assignment/Quiz/Mid-term
30.	Review of Sampling theorem	Flipped Classroom	EC3103.3	Assignment/Quiz/Mid-term
31.	Quantization (uniform and non-uniform quantization)	Lecture	EC3103.3	Assignment/Quiz/Mid-term
32.	Non-Uniform Quantization: companding, μ-Law and A-Law compressors	Lecture	EC3103.4	Assignment/Quiz/Mid-term
33.	Tutorial			
34.	Baseband digital communication systems: Pulse Code Modulation (PCM): modulators and demodulators	Lecture	EC3103.4	Assignment/Quiz/End term
35.	Signal-to-Noise Ratio (SNR) in PCM (AWGN Channel)	Lecture	EC3103.4	Assignment/Quiz/End term
36.	Differential Pulse Code Modulation (DPCM): modulators and demodulators	Lecture	EC3103.3	Assignment/Quiz/End term
37.	Delta Modulation (DM): modulators and demodulators	Lecture	EC3103.3	Assignment/Quiz/End term
38.	Tutorial			
39.	Signal-to-Noise Ratio (SNR) & probability of error (Pe) of in DM (AWGN Channel)	Lecture	EC3103.4	Assignment/Quiz/End term
40	Adaptive Delta Modulation (ADM): modulators and demodulators	Lecture	EC3103.3	Assignment/Quiz/End term
41	Time Division Multiplexing (TDM)	Flipped Classroom	EC3103.4	Assignment/Quiz/End term
42	Line coding	Lecture	EC3103.4	Assignment/Quiz/End term
43.	Tutorial			
44,45	source encoding techniques	Lecture	EC3103.6	Assignment/Quiz/End term
46,47	channel encoding techniques	Lecture	EC3103.6	Assignment/Quiz/End term
48	Digital modulation schemes, Coherent Binary & M-ary Schemes: Amplitude Shift Keying (ASK)	Lecture	EC3103.5	Assignment/Quiz/ETE

49	Coherent Binary Schemes: Phase Shift Keying (PSK)	Flipped classroom	EC3103.5	Assignment/Quiz/End term
50	Coherent Binary Schemes: Frequency Shift Keying (FSK)	Lecture	EC3103.5	Assignment/Quiz/End term
51	Applications: wireless sensor networks	Lecture	EC3103.5	Assignment/Quiz/End term
50.	spread spectrum	Lecture	EC3103.5	Assignment/Quiz/End term
51	mobile communication	Lecture	EC3103.5	Assignment/Quiz/End term
52	Revision			

A. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC3103.1].	Demonstrate the use of Fourier transform to represent amplitude modulation scheme in time and frequency domain	2	2	2	1	0	0	0	0	0	1	1	1	2	2	0
[EC3103.2].	Compute various parameters & compare different angle modulation schemes in time and frequency domain	2	1	2	1	0	0	0	0	0	0	0	1	2	1	0
[EC3103.3].	Demonstrate use of sampling theorem for baseband signals to mitigate aliasing	2	2	1	1	0	1	0	0	0	0	1	0	2	2	0
[EC3103.4]	Analyse baseband communication techniques in time domain	2	1	1	1	0	0	0	0	0	1	0	0	2	2	0
[EC3103.5]	Represent baseband pulse signals into signals using appropriate line coding technique	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
[EC3103.6]	Construct source codes and/or channel codes (create)	2	2	0	0	0	0	0	0	0	0	0	0	2	1	0
		2	2	2	1	0	0	0	0	0	0	1	1	2	2	0

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

CMOS VLSI Design EC3104 | 4 Credits | 3 1 0 4

Session: July 23– December 23 | Faculty: Dr. Deepika Bansal | Class: Core Course

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a Core Course, to introduce the field of VLSI design for pursuing research & development in the field of VLSI Design, Nano-devices and its applications, Low Power VLSI Design. This course offers in depth knowledge of MOSFET working & characteristics, CMOS circuit fabrication, static and timing analysis and gives an introductory level knowledge on low power techniques. Students are expected to have background knowledge of Analog Electronic and Digital Electronics for better understanding of the course and this course is a prerequisite for Low Power VLSI Design Course.

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

[EC3104.1] Illustrate fabrication and working of MOS device for calculating current and voltages**.**
[EC3104.2] Analyze CMOS circuits in behavioral, structural and geometrical domain for CMOS implementation.
[EC3104.3] Compute noise margin for CMOS circuits using mathematical calculations.
[EC3104.4] Compute propagation delays for CMOS circuits using mathematical calculations.
[EC3104.5] Design combinational and sequential logic circuits using different implementation strategies for digital circuits.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	20
	Sessional Exam II (Close Book)	20
	In class Quizzes and Assignments	20
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss the class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given. These assignments are limited to a maximum of 5 throughout the entire semester.	
Activity Assignment & Quiz (Summative)	Minimum 3 Quiz will be given.	

E. SYLLABUS

Introduction: VLSI technology trends, performance measures and Moore's law. **MOS devices and circuits:** MOS transistors, Study of depletion and enhancement mode operations, Threshold Voltage. Second order effects in MOSFETs. **Fabrication of ICs:** Lithographic process of MOS and CMOS fabrication, N-well, P-well and twin tub processes, Latch-up in CMOS, SOI process, VLSI Yield and economics. **MOS Circuit design & layouts**: Implementation of Boolean functions and combinational circuits using switch logic & gate logic, Pass transistors and transmission gates, Pseudo NMOS inverter, Dynamic and clocked CMOS inverters, Clocking strategies. **Basic circuit concepts and performance estimation:** Sheet resistance, Standard unit of capacitance, Estimation of delay in NMOS and CMOS inverters. **Sub system design:** Design strategies, Design issues and structured approach, Design examples such as Adders, ALUs and Shifters, Design of sequential circuits. **Memory Arrays:** SRAM, DRAM. **Current trends:** BiCMOS devices and circuits.

F. TEXT BOOK

S. M. Kang & Y. Leblebici, CMOS digital Integrated circuits design and analysis, Tata McGraw Hill, 3rd edition, 1996.

G. REFERENCE BOOKS

1. Jan. M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits, (2e), Pearson, 2003.

2. Neil H. E. Weste & Kamran Eshraghian, Principles of CMOS VLSI Design, (2e), Addison Wesley, 1993.

H. Lecture Plan:

Lecture No.	*Topics to be Covered.*	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Overview of the Course	To acquaint and clear teachers expectations and understand student expectations	Lecture	[3104.1]	NA
2-4	VLSI technology trends, performance measures and Moore's law.	Interpret VLSI technology trends	Lecture	[3104.1]	Class Quiz
5	MOS structure	Recall the operation of JFET and MOSFET	Lecture	[3104.1]	Class Quiz
6-7	**Fabrication of ICs:** Lithographic process of MOS and CMOS fabrication, N-well, P-well and twin tub processes, Latch-up in CMOS, SOI process, VLSI Yield and economics.	understand fabrication of MOS	Lecture	[3104.1]	Class Quiz Mid-term-I
8	**MOS devices and circuits:** MOS transistors, Study of depletion and enhancement mode operations	understand modes of operation for the MOS	Lecture	[3104.1]	Class Quiz Mid-term-I
9, 10	Energy band diagram and Fermi level	Recall Energy band diagram for semiconductors and extend it for MOS	Lecture	[3104.1]	Class Quiz Mid-term-I End-term
11	MOSFET working and its region of operation	Analyze MOSFET operating region	Lecture	[3104.1]	Class Quiz Mid-term-I
12	Threshold Voltage & Derivation	Determine the components of Threshold voltage for MOS	Lecture	[3104.1]	Class Quiz Mid-term-I End-term
13	Threshold Voltage	Calculating threshold voltage for a device	Tutorial	[3104.1]	Class Quiz Mid-term-I End-term
14	MOS current Derivation	Estimate MOS current based on applied voltage	Lecture Tutorial	[3104.1]	Class Quiz Mid-term-I End-term
15	Body Bias Effect, Channel Length Modulation	Evaluate effect of body bias and channel length modulation on MOS current	Lecture	[3104.1]	Class Quiz Mid-term-I End-term
16	MOS Scaling, Second order effects in MOSFETs	Interpret effect of scaling on capacitance, current and power density of MOS	Lecture Tutorial	[3104.2]	Class quiz Mid-term-I
17-18	Resistive Load Inverter	Sketch Voltage Transfer Characteristics for Inverter and identify device operation	Lecture	[3104.2]	Class Quiz Mid-term-I End-term

19-20	Analysis of NMOS and CMOS inverter circuits (Noise Margin)	Analyze the circuit to find Noise Margin	Lecture	[3104.2]	Class Quiz Mid-term-I End-term
21	Noise Margin	Calculation of Noise Margin for a circuit	Tutorial	[3104.3]	Class Quiz Mid-term-I End-term
22	Power dissipation in CMOS	Determine the power requirements of the circuit	Lecture	[3104.3]	Class Quiz Mid-term-I
23-25	Estimation of delay in NMOS and CMOS inverters	Analysis of circuits for delay calculations	Lecture	[3104.3]	Class Quiz Mid-term-II End-term
26	**Delay calculations**	Solving numerical to calculate delay in circuits	Tutorial	[3104.4]	Class Quiz Mid-term-II End-term
27	**Basic circuit concepts and performance estimation:** Sheet resistance, Standard unit of capacitance,	Understand parasitic resistance and capacitance	Lecture	[3104.4]	Class Quiz Mid-term-II End-term
28	**calculation of circuit parasitic**	Solve problems for calculating parasitic capacitances	Tutorial	[3104.4]	Class Quiz Mid-term-II End-term
29-30	Implementation of Boolean functions and combinational circuits using CMOS logic	Implementation of Boolean functions and combinational circuits using different circuits studied	Lecture Tutorial	[3104.5]	Class Quiz Mid-term-II End-term
31-32	Stick diagrams, Design rules and layouts	Implementation of circuits using stick diagrams and layouts	Lecture Tutorial	[3104.5]	Class Quiz, Mid-term-II End-term
33-34	Pass transistors and transmission gates	Explain TG operation and implementation of circuits	Lecture	[3104.5]	Class Quiz Mid-term-II End-term
35	Implement circuits using TG and pass transistor	Implement circuits using TG and pass transistor	Tutorial	[3104.5]	Class Quiz Mid-term-II End-term
36	Pseudo NMOS inverter	Implementation of Boolean functions and combinational circuits using different circuits studied	Lecture	[3104.5]	Class Quiz Mid-term-II End-term
37, 38	Dynamic and clocked CMOS inverters, Clocking strategies	Explain the working of dynamic CMOS circuits and understand its limitations	Lecture	[3104.5]	Class Quiz Mid-term-II End-term
39, 40	Domino Logic	Explain the working of domino CMOS circuits	Lecture Tutorial	[3104.5]	Class Quiz Mid-term-II End-term
41-42	Flip flops and sequential circuits using various logic families	Recall flip-flops operation and implement them using CMOS circuits	Lecture Tutorial	[3104.5]	Class Quiz End-term

43-44	**Sub system design:** Design strategies, Design issues and structured approach, Design examples such as Adders, ALUs and Shifters,	Understand sub-system design strategies	Lecture	[3104.5]	Class Quiz End-term
45-46	**Memory Arrays:** SRAM, DRAM.	Understand working of memories	Lecture	[3104.5]	Class Quiz End-term
47	**Current trends:** BiCMOS devices and circuits.	Give exposure to latest devices and circuits	Lecture	[3104.5]	Class Quiz
48	**Summary for the course**	Quick summary of important concepts	Lecture	NA	NA

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[3104.1]	Illustrate fabrication and working of MOS device for calculating current and voltages	2												1	2	1
[3104.2]	Analyze CMOS circuits in behavioral, structural and geometrical domain for CMOS implementation	2	2	1	1									2	2	
[3104.3]	Compute noise margin for CMOS circuits using mathematical calculations	1	3	1	1									2	1	
[3104.4]	Compute propagation delays for CMOS circuits using mathematical calculations	2	2	3										2	2	1
[3104.5]	Design combinational and sequential logic circuits using different implementation strategies for digital circuits	2	2	3										2	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics and Communication Engineering (SEEC)

Department of Electronics and Communication Engineering
Course Hand-out

VLSI Lab EC 3130 | 1 Credits | 0 0 2 1

Session: Aug 2023– Dec 2023 | Faculty: Dr. Deepika Bansal | Class: Practical Course

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a Core Course, targeting students who wish to pursue research & development in the field of VLSI Design, Nano-devices and its applications, Low Power VLSI Design. This course offers in depth knowledge of CMOS fabrication flow, MOSFET working & characteristics, Noise margin & delays and gives an introductory level knowledge on low power techniques. Students are expected to have background knowledge on Analog Electronic and Digital Electronics for better understanding of the course and this course is a prerequisite for Low Power VLSI Design Course.

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

EC3130.1 Demonstrate VLSI EDA software using SPICE coding and schematic
EC3130.2 Demonstrate current-voltage characteristics for MOS for understanding device working
EC3130.3 Calculate delays and noise margin for CMOS circuits
EC3130.4 Observe DC and transient response of CMOS logic gates
EC3130.5 Design and analyse combinational circuits using CMOS
EC3130.6 Design and analyse sequential circuits using CMOS

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. List of Experiment:

S.	Topics	Session Outcome	Mode of Delivery	Corresponding CO
1.	Verify the Input and output characteristic of MOS Transistors using HSPICE.	Understand device working	**Practical**	**EC3130.2**
2.	Analyse a resistive load inverter for Transient and DC Analysis using HSPICE.	Analyze resistive load inverter	**Practical**	**EC3130.1**
3.	Simulate CMOS inverter to perform DC and transient response. Also analyse the effects of different width, length, supply voltage and capacitance on the responses using HSPICE.	Analyze MOS inverter	**Practical**	**EC3130.4**
4.	Simulate CMOS inverter to perform transient response and obtain the rise time, fall time and propagation delays on inverters.	Study transient response	**Practical**	**EC3130.3**
5.	Design a CMOS inverter using Schematic and analyse the different responses.	Make entry as schematic	**Practical**	**EC3130.2**

6.	Design the schematic of 2-input NAND and NOR gate and simulate it to observe the DC and transient response using HSPICE.	Make entry as schematic	**Practical**	**EC3130.4**
7.	Design sub circuits for gates and analyse different circuits using HSPICE	Understand sub-circuit design	**Practical**	**EC3130.1**
8.	Design & Simulate Combinational Circuits (higher order adder) using HSPICE.	Simulate combinational circuit	**Practical**	**EC3130.5**
9.	Design & Simulate Combinational Circuits (higher order MUX) using HSPICE.	Simulate combinational circuit	**Practical**	**EC3130.5**
10.	Design and simulate Multiplexers using Transmission Gate using HSPICE.	Simulate combinational circuit	**Practical**	**EC3130.5**
11.	Design and simulate schematic of Decoder using Transmission Gate.	Simulate combinational circuit	**Practical**	**EC3130.5**
12.	Design and simulate Combinational Circuit using Dynamic logic family and calculate power using HSPICE.	Simulate combinational circuit	**Practical**	**EC3130.5**
13.	Design and simulate Sequential Circuit using Domino logic family and calculate power using HSPICE.	Simulate sequential circuit	**Practical**	**EC3130.6**

E. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EC3130.1	Illustrate MOS fabrication and its working for skilled employability	1		1	1									1	2	1
EC3130.2	Analyze CMOS circuits in behavioral, structural and geometrical domain to have better skill set		1	2	2	1						1	1	2	2	
EC3130.3	Design and discuss CMOS circuits for delays and noise margin	1	1	2	1	1								2	1	
EC3130.4	Design and analyze different combinational logic circuits and systems using CMOS and other logic families to promote entrepreneurship	2	2	2	2	2		1				1	1	2	2	1
EC3130.5	Implement sequential circuits using CMOS and other logic families	1	2			1	1		1			1	1	2	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

Faculty of Engineering | School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Modern Antenna Technology | EC4141 | 3 Credits | 3 0 0 3

Session: July – Nov 23 | Faculty: Dr. Amit Rathi | Class: Program Elective

A. Introduction: The course provides the fundamentals in the theory and practice of antenna parameters and the antenna deployment in the modern wireless telecommunication systems. The course provides knowledge of Special/Modern antenna: Reflector antenna, Microstrip antennas, Frequency Independent antenna, Reconfigurable antenna, Active antenna, Dielectric antennas, Electronic band gap structure and applications. Smart Antennas etc. This course also provides measurement of some antenna parameter.

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

[EC4141.1]	Explain and **Analyse** of basic Parameter of Antenna for lifelong learning and encouraging entrepreneurship.
[EC4141.2]	Study the various types of Reflector antenna and its applications.
[EC4141.3]	Explain and Classify the construction and characteristics of Microstrip antennas with different feeding techniques and models.
[EC4141.4]	Study the various types of Modern antennas and its applications.
[EC4141.5]	Study the Smart Antenna with its benefits and drawbacks.
[EC4141.6]	Develop the experimental skills needed for Antenna measurements for performance analysis and hence result in scope of entrepreneurship.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	**Description**	**Maximum Marks**
	Sessional Exam I (1hr. 30 Min)	30
	Quizzes and assignments *Weekly/ bi-monthly* Online Course Research Paper Review Research Project Semester-long Hackathon MOOC courses on the SWAYAM/NPTEL In class Quizzes, courses (online or offline), platforms (with passing certificate), long term hackathons, Activity feedback (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (3 hours)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Makeup Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

EC4141 Modern Antenna Technology [3 0 0 3]

Antenna Terminology: Basic antenna parameters, Thevenin Equivalent of Transmitter Antenna, patterns, isotropic antenna, Beam Area or Beam Solid Angle Gain, Radiation Density, Radiation Density, Power Gain, Antenna Efficiency Factor, Input Impedance, Radiation Resistance, Image Antenna Directivity, lobes, polarizations, Field regions. Reflector antenna- Introduction, plane Reflector, corner, parabolic, spherical reflector, Paraboloidal Reflector and its gain, Microstrip antennas: Microstrip radiators, various microstrip antenna configurations, Feeding Structures for Microstrip Patch Antennas and Comparison of Feeds, Analytical models for microstrip antennas, Transmission line model, Cavity Model, Full wave analysis of microstrip antennas. Modern antennas: Frequency Independent antenna, Reconfigurable antenna, Active antenna, Dielectric antennas, Electronic band gap structure and applications. Smart Antennas –Introduction, smart antenna analogy, smart antenna benefits & drawbacks, antenna beamforming. Antenna Measurements: Introduction, Antenna ranges, Radiation pattern, Return loss, Gain /Directivity measurements, Polarization measurements.

References:

1. C. A. Balanis, *Antenna Theory*, (3e), John Wiley & Sons, Inc, U.K. 2005.
2. J. D. Kraus, *Antennas*, (1e), McGraw-Hill, New York, 1988.
3. R. E Collin, *The Receiving Antennas*, (1e), McGraw-Hill, 1969.
4. C. Fernandes, R. K. Jha, C. Salema, *Solid Dielectric Horn Antennas*, (1e), Artech House, 1998.
5. S. Drabowitch, *Modern Antennas,* (2e), Springer Publications, 2007.

A. Lecture Plan:

Lec No	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1.	*Antenna Terminology: Basic antenna parameters,*	*Interaction with students and give basic about subject*	*Lecture*	*EC4141.1*	Assignments Class Quiz MTE ETE
2.	*patterns, isotropic antenna*	*Interaction with students and give basic about subject*	*Lecture*	*EC4141.1*	Assignments Class Quiz MTE ETE
3.	*Gain, Directivity,*	*Interaction with students and give basic about subject*	*Lecture*	*EC4141.1*	Assignments Class Quiz MTE ETE
4.	*lobes,*	*Interaction with students and give basic about subject*	*Lecture*	*EC4141.1*	Assignments Class Quiz MTE ETE
5.	*polarizations*	*Interaction with students and give basic about subject*	*Lecture*	*EC4141.1*	Assignments Class Quiz MTE ETE
6.	*Field regions*	*Interaction with students and give basic about subject*	*Lecture*	*EC4141.1*	Assignments Class Quiz MTE ETE
7.	Reflector antenna- Introduction,	Describes	Lecture	EC4141.2	Assignments Class Quiz MTE ETE
8.	plane Reflector, corner,	Describes	Lecture	EC4141.2	Assignments Class Quiz MTE ETE
9.	parabolic, spherical reflector.	Describes	Lecture	EC4141.2	Assignments Class Quiz MTE

					ETE
10.	Microstrip antennas	Understanding of nature and laws of MSA	Lecture	EC4141.3	Assignments Class Quiz MTE ETE
11.	Microstrip radiators, various microstrip antenna configurations,	Understanding of nature and laws of MSA	Lecture	EC4141.3	Assignments Class Quiz MTE ETE
12.	Feeding method	Understanding of nature and laws of MSA	Lecture	EC4141.3	Assignments Class Quiz MTE ETE
13.	Analytical models for microstrip antennas,	Understanding of nature and laws of MSA	Lecture	EC4141.3	Assignments Class Quiz MTE ETE
14.	Transmission line model,	Understanding of nature and laws of MSA	Lecture	EC4141.3	Assignments Class Quiz MTE ETE
15.	Cavity Model,	Understanding of nature and laws of MSA	Lecture	EC4141.3	Assignments Class Quiz MTE ETE
16.	Full wave analysis of microstrip antennas	Understanding of nature and laws of MSA	Lecture	EC4141.3	Assignments Class Quiz MTE ETE
17.	Modern antennas: Frequency Independent antenna,	Understanding of various type of Modern Antenna	Lecture	EC4141.4	Assignments Class Quiz MTE ETE
18.	Reconfigurable antenna,	Understanding of various type of Modern Antenna	Lecture	EC4141.4	Assignments Class Quiz MTE ETE
19.	Active antenna,	Understanding of various type of Modern Antenna	Lecture	EC4141.4	Assignments Class Quiz MTE ETE
20.	Dielectric antennas,	Understanding of various type of Modern Antenna	Lecture	EC4141.4	Assignments Class Quiz MTE ETE
21.	Electronic band gap structure and applications	Understanding of various type of Modern Antenna	Lecture	EC4141.4	Assignments Class Quiz MTE ETE
22.	Electronic band gap structure and applications	Understanding of various type of Modern Antenna	Lecture	EC4141.4	Assignments Class Quiz MTE ETE
23.	Electronic band gap structure and applications	Understanding of various type of Modern Antenna	Lecture	EC4141.4	Assignments Class Quiz MTE ETE

24.	Smart Antennas –Introduction	Describes Smart Antenna use for wireless Communication	Lecture	EC4141.5	Assignments Class Quiz MTE ETE
25.	smart antenna analogy,	Describes Smart Antenna use for wireless Communication	Lecture	EC4141.5	Assignments Class Quiz MTE ETE
26.	smart antenna benefits & drawbacks,	Describes Smart Antenna use for wireless Communication	Lecture	EC4141.5	Assignments Class Quiz MTE ETE
27.	antenna beamforming	Describes Smart Antenna use for wireless Communication	Lecture	EC4141.5	Assignments Class Quiz MTE ETE
28.	Antenna Measurements: Introduction,	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
29.	Antenna ranges,	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
30.	Antenna ranges,	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
31.	Antenna ranges,	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
32.	Radiation pattern,	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
33.	Return loss,	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
34.	Return loss,	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
35.	Gain	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
36.	Directivity measurements	Understanding about Measurements and its importance	Lecture	EC4141.6	Assignments Class Quiz MTE ETE
37.	Polarization measurements.	Understanding about Measurements	Lecture	EC4141.6	Assignments Class Quiz MTE

		and its importance			ETE

F. Course Outcome Attainment Level Matrix:

CO	STATEMENT	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 40%**												ATTAINMENT OF PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC4141.1]	Understand basic Parameter of Antenna for lifelong learning and encouraging entrepreneurship.	3	3	1	1	1	1	0	0	0	0	0	1	3	0	2
[EC4141.2]	Study the various types of Reflector antenna and its applications.	3	3	1	1	1	0	0	0	0	0	0	0	3	0	2
[EC4141.3]	Learn and classify the construction and characteristics of Microstrip antennas with different feeding techniques and models.	2	3	2	1	1	0	0	0	0	0	0	0	3	0	2
[EC4141.4]	Study the various types of Modern antennas and its applications.	2	3	2	1	1	0	0	0	0	0	0	0	3	0	2
[EC4141.5]	Study the Smart Antenna with its benefits and drawbacks.	3	3	1	2	1	0	0	0	0	0	0	0	2	1	2
[EC4141.6]	Develop the experimental skills needed for Antenna measurements for performance analysis and hence result in scope of entrepreneurship.	2	2	2	2	1	1	1	1	1	1	1	2	2	1	2

0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Analog VLSI EC4142 | 3 Credits | 3 0 0 3

Session: Aug 23– Dec 23 | Faculty: Dr. Neha Singh | Class: Program Elective Course (Minor Specialization)

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a program elective Course. The course is mandatory for minor specialization in VLSI. It targets the students interested in development of analog VLSI circuits and systems. The course offers important topics for CMOS analog integrated circuits. It covers circuit operation, circuit analysis, design techniques and methodologies, implementation approaches and key building blocks for integrated circuit designs so that one can develop an intuition to design circuits based on specific requirements in their career.

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

[EC4143.1] Develop small signal equivalent models for MOS transistor and its analog circuits for calculating small signal parameters. **(Understand)**
[EC4143.2] Analytically quantify the behavior of analog amplifiers **(Analysis)**
[EC4143.3] Analyze current mirrors and reference circuits **(Analysis)**
[EC4143.4] Analyze the effect of Feedback on amplifiers **(Analysis)**
[EC4143.5] Analyze MOS operational amplifier circuits **(Apply)**
[EC4143.6] Understand the operation of switched capacitors **(Understand)**

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	30
	In class Quizzes and Assignments	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Activity Assignment & Quiz (Summative)	Minimum 3 Quiz will be given. If a student enrolls and submits all the assignments for NPTEL course on Analog VLSI Design, he/she is awarded 10 Marks in CWS with 20 marks for quizzes.	

E. SYLLABUS

Review of MOS Transistor operation models and equivalent circuits for low and high frequency. Single-Stage Amplifiers: CS, CG, CD, Cascode amplifiers. Differential Amplifiers: Common mode, differential mode response analysis and gain calculation. Passive and Active Current Mirrors: Cascode current mirror, current mirror as an active device. Miller effect for frequency response of amplifiers. Feedback amplifiers. Theory and design of MOS Operational Amplifier, Stability and Frequency compensation of operational amplifiers. Comparators and Voltage Reference Sources. Switched Capacitor Circuits: Principles of operation of Switched Capacitor Circuits, Switched Capacitor Filters.

REFERENCE BOOKS

1. Behzad, Razavi, Design of Analog CMOS Integrated Circuits, (2e), McGraw Hill, 2001.
2. Allen Holberg, CMOS Analog Integrated Circuit Design, (3e), Oxford University Press, 2012.
3. P. R.Gray, Hurst, Lewis and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, (4e), John Wiley, 2001.

F. Lecture Plan:

Lect No.	Topics to be Covered.	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1.	Introduction to the course and teacher's expectation	Students understand the expectations	Lecture	NA	NA
2-3	Review of MOS Transistor operation models	Revise the structure and operation of MOSFETs	Lecture	EC4143.1 EC4143.2	Class test MTE
4-5	MOS equivalent circuits for low and high frequency.	Develop models for MOSFET at low and high frequencies	Lecture	EC4143.1	Class test MTE
6-10	Single-Stage Amplifiers: CS, CG, CD, Cascode amplifiers	Design and analyze single stage MOS amplifiers	Lecture	EC4143.2	Class test MTE ETE
11-13	Differential Amplifiers: Common mode, differential mode response analysis and gain calculation.	Design and analyze differential amplifiers	Lecture	EC4143.2	Class test MTE ETE
14-16	Passive and Active Current Mirrors: Cascode current mirror, current mirror as an active device.	Understand the working of active and passive current mirrors	Lecture	EC4143.3	Class test MTE ETE
17-19	Miller effect for frequency response of amplifiers.	Analyze frequency response of single stage and multistage amplifiers	Lecture	EC4143.4	Class test MTE ETE
20-24	Feedback amplifiers	Understand the effect of positive and negative feedback on circuits	Lecture	EC4143.4	Class test MTE ETE
25-27	Theory and design of MOS Operational Amplifier	Understand each stage of an operational amplifier	Lecture	EC4143.5	Class test MTE ETE
28-30	Stability and Frequency compensation of operational amplifiers	Analyze frequency response of operational amplifiers	Lecture	EC4143.5	Class test MTE ETE
31-32	Comparators and Voltage Reference Sources	Understand working of comparators and voltage reference sources	Lecture	EC4143.5	Class test ETE
33-36	Switched Capacitor Circuits: Principles of operation of Switched Capacitor Circuits, Switched Capacitor Filters	Understand switched capacitors filters	Lecture	EC4143.6	Class test ETE

A. Course Articulation Matrix: (Mapping of COs with POs)

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	Develop small signal equivalent models for MOS transistor and its analog circuits for calculating small signal parameters. **(Understand)**	3	1	2	0	0	0	0	0	0	0	0	0	0	1	0
2	Analytically quantify the behavior of analog amplifiers **(Analysis)**	3	1	2	0	0	0	0	0	0	0	0	0	0	1	0
3	Analyze current mirrors and reference circuits **(Analysis)**	3	1	2	0	0	0	0	0	0	0	0	0	0	1	0
4	Analyze the effect of Feedback on amplifiers **(Analysis)**	3	1	2	0	0	0	0	0	0	0	0	0	0	1	0
5	Design MOS operational amplifier circuits **(Apply)**	3	1	2	0	0	0	0	0	0	0	0	0	0	1	0
6	Understand the operation of switched capacitors **(Understand)**	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0

Dr Neha Singh

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

VLSI CAD EC4143 | 3 Credits | 3 0 0 3

Session: Aug 23– Dec 23 | Faculty: Dr. Neha Singh | Class: Program Elective Course (Minor Specialization)

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a program elective Course. The course is mandatory for minor specialization in VLSI. It targets the students interested in development of VLSI design tools. The course focuses on introducing CAD design issues that span the spectrum from circuit modeling with hardware description languages to cell-library binding. It covers relevant mathematical topics followed by study of selective CAD problems and algorithms to solve these problems. This course will form the base for students to read, understand and analyse specialized books and research articles in this field. Students are expected to have elementary knowledge of HDL programming, MOS circuits and digital IC design for better understanding of the course.

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

[EC4143.1] Understand the requirements from a High-level Hardware Description Language (HDL) and CAD Tools to be able to achieve the best designs with the CAD tools
[EC4143.2] Make use of graph algorithms and Boolean algebra for VLSI Design Automation
[EC4143.3] Choose scheduling algorithms which underpin architectural level synthesis
[EC4143.4] Assess resource sharing and binding algorithms which underpin architectural level synthesis
[EC4143.5] Apply logic optimization for two-level and multiple level combinational and sequential circuits for user-defined constraints
[EC4143.6] Understand Timing Analysis and logical effort for MOS circuits

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	30
	In class Quizzes/Assignments/ Research work	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Activity Assignment & Quiz (Summative)	Minimum 3 Quiz will be given. 01 research report needs to be submitted.	

E. SYLLABUS

Introduction to CAD tools: Evolution of Design Automation, Types of CAD tools. **Algorithmic Graph Theory:** Graphs, graph optimization, basic algorithms. Hardware Modelling. **Simulation:** Simulation, Gate-level modelling and simulation, Switchlevel modelling and simulation. **Combinational Logic Synthesis:** Binary Decision Diagrams, Two Level Logic Synthesis. **Logic synthesis:** two-level and multilevel Combinational Logic and sequential logic optimization. **Basic concepts of high-level synthesis:** partitioning, scheduling, allocation and binding, Memory modeling Synthesizable and non-synthesizable constructs, Logic Optimization, Optimizing logic using resource sharing. **Estimating delays in a circuit:** issues in Dynamic and Static Timing Analysis. **Introduction to Logical Effort:** Multistage Logic Networks, Logical Effort and Gain Based Synthesis, Logical Effort Optimizing performance.

F. REFERENCE BOOKS

1. D. Micheli, Synthesis and optimization of digital systems, (1e), Mc Graw Hill, 2003.
2. S.Imam, M. Pedram, Logic Synthesis for Low Power VLSI Designs, (1e), Kluwer, 1997.
3. M.Smith, Application Specific ICs, (1e), Pearson, 1997.
4. S.Palnitkar, Verilog HDL, A Guide to Digital Design and Synthesis, (2e), Prentice Hall PTR, 2003.
5. S.Brown S., Z.Vranesic, Fundamentals of Digital Logic with Verilog Design, (2e), TMH, 2007.
6. Rabaey, J. M., Chandrakasan, A. P., & Nikolic, B., Digital integrated circuits (2e), Englewood Cliffs, Prentice hall, 2002.

G. Lecture Plan:

Lect No.	Topics to be Covered.	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1.	Overview of the Course. Introduction to CAD tools: Evolution of Design Automation, Types of CAD tools	To acquaint and clear teacher's expectations and understand student expectations. To understand need and features of CAD Tools	Lecture	EC4143.1	Class test
2-3	**Algorithmic Graph Theory:** Graphs, graph optimization, basic algorithms	To understand graph terminology, Data Structures for Graphs Representation and computational complexity of algorithms for drawing graphs for systems	Lecture	EC4143.1 EC4143.2	Class test MTE ETE
4	Hardware modelling	To understand the need of modelling at different levels of abstraction for CAD	Lecture	EC4143.1	Class test MTE
5	**Simulation:** Simulation, Gate-level modelling, and simulation, Switch level modelling and simulation	To model the system at gate and switch level	Lecture	EC4143.2	Class test MTE ETE
6	**Basic concepts of high-level synthesis:** partitioning, scheduling, allocation, and binding	To understand the concept of circuit partitioning, scheduling, allocation, and binding	Lecture	EC4143.2	Class test MTE ETE
7-8	**Basic concepts of high-level synthesis:** partitioning,	Understand partitioning algorithms	Lecture	EC4143.2	Class test MTE ETE
9	**Partitioning algorithms**	Implement partitioning algorithms	Tutorial	EC4143.2	Class test MTE

					ETE
10-11	Specifications and problem formulation for architectural synthesis-Temporal and spatial domain	Understand the specifications for temporal and spatial domain synthesis for area and performance estimation	Lecture	EC4143.3 EC4143.4	Class test MTE ETE
12-14	**Architectural optimization**	Apply strategies for architectural optimization	Lecture	EC4143.1	Class test MTE ETE
15	Implement algorithms for architectural synthesis	Identify optimized architecture based on constraints	Tutorial	EC4143.3 EC4143.4	Class test MTE ETE
16-17	**Scheduling**	Implement various scheduling strategies-ASAP, ALAP and relative scheduling	Lecture	EC4143.3	Class test MTE ETE
18-19	Implement various approaches for scheduling graphs	Apply scheduling concepts with user constraints	Tutorial	EC4143.3	Class test MTE ETE
20-21	**Resource sharing and binding**	Implement various sharing and binding strategies	Lecture	EC4143.4	Class test MTE ETE
22-23	**Resource sharing and binding**	Resolve constraints for resource binding	Tutorial	EC4143.4	Class test MTE ETE
24-29	**Combinational Logic Synthesis, Logic synthesis:** two-level and multilevel Combinational Logic and sequential logic optimization	Introduce positional cube notation and perform optimization of combinational and sequential logic	Lecture	EC4143.5	Class test ETE
30-31	**URP and tautology**	Apply positional cube notations for optimization	Tutorial	EC4143.5	Class test ETE
32-33	Cell-library binding	Perform optimization using resource sharing	Lecture	EC4143.4	Class test ETE
34	Cell-library binding	Solve problems for library binding based on cost constraints	Tutorial	EC4143.4	Class test ETE
35	**Estimating delays in a circuit:** issues in Dynamic and Static Timing Analysis.	Estimate delays in circuits	Lecture	EC4143.6	Class test ETE
36	**Introduction to Logical Effort:** Multistage Logic Networks, Logical Effort and Gain Based Synthesis, Logical Effort Optimizing performance.	Calculate logical efforts for VLSI circuits	Lecture	EC4143.6	Class test ETE

A. Course Articulation Matrix: (Mapping of COs with POs)

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	Understand the requirements from a High-level Hardware Description Language (HDL) and CAD Tools to be able to achieve the best designs with the CAD tools	0	0	0	0	1	0	0	0	0	0	0	2	0	1	0
2	Apply graph algorithms and Boolean algebra for VLSI Design Automation	2	0	0	0	0	0	0	0	0	0	0	0	1	1	0
3	Apply scheduling algorithms which underpin architectural level synthesis	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
4	Apply resource sharing and binding algorithms which underpin architectural level synthesis	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
5	Apply logic optimization for two-level and multiple level combinational and sequential circuits for user-defined constraints	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
6	Understand Timing Analysis and logical effort for MOS circuits	0	2	1	0	0	0	0	0	0	0	0	0	1	1	0

Dr Neha Singh

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

WIRELESS & ADHOC NETWORKS | EC 4144 | 3 Credits | 3 0 0 3

Session: July 23 – Dec. 23 | Faculty: Dr. Rohit Mathur | Class: Dept. Elective (VII Sem)

A. Introduction: Ad hoc networks are autonomous systems which comprise a collection of mobile nodes that use wireless transmission for communication. They are self-organized, self-configured, and self-controlled infrastructure-less networks. This type of network can be set up or deployed anywhere and anytime because it poses very simple infrastructure setup and no or minimal central administration. These networks are mainly used by community users such as military, researchers, business, students, and emergency services. This course addresses and explains network concepts, mechanism, design, and performance. Presents the latest techniques, solutions, and support to understand the concepts easily with suitable examples.

This course also covers fundamentals of wireless network technology and distributed sensor networks. A wireless sensor network (WSN) generally consists of compact low power sensors, which collect information and pass the information via wireless networks to achieve a high level of desired monitoring and control in coordinated manners.

B. Course Objectives: At the end of the course, students will be able to

[EC 4144 . 1] Explain the significance and issues with infrastructure-less networks (L2)
[EC 4144 . 2] Illustrate relevant MAC protocol in the context of Ad Hoc networks (L2)
[EC 4144 . 3] Illustrate relevant routing protocol in the context of Ad Hoc networks (L2)
[EC 4144 . 4] Identify the appropriate transport mechanism for a given Ad Hoc nwk scenario (L3)
[EC 4144 . 5] Select the appropriate data dissemination technique for a given WSNs scenario (L3)
[EC 4144 . 6] Illustrate relevant localization mechanism in the context of WSNs (L2)

C. Program Outcomes and Program Specific Outcomes

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam (Close Book)	30
	In class Quizzes, Assignment, **Research Paper Publication***	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home. However, a student is expected to participate and perform these assignments with full zeal since the activity participation by a student will be assessed and marks will be awarded.	

E. Syllabus

Unit-I: Ad-Hoc Wireless Networks:

Introduction and Issues in Ad-Hoc Wireless Networks. MAC Protocols, Issues, Classifications of MAC protocols, Multi-channel MAC & Power control MAC protocol. Issues – Classifications of routing protocols – Hierarchical and Power aware.

Unit-II: routing & Ad Hoc Transport Layer:

Routing, Multicast routing –Classifications, Tree based, Mesh based. Ad Hoc Transport Layer Issues. TCP Over Ad Hoc –Feedback based, TCP with explicit link, TCP-BuS, Ad Hoc TCP, and Split TCP.

Unit-II: Wireless Sensor Networks:

Introduction – Sensor Network Architecture, Data dissemination, Gathering. MAC Protocols, self-organizing, Hybrid TDMA/FDMA and CSMA based MAC, WSN routing, OLSR, AODV. Localization Indoor and Sensor Network Localization. QoS in WSN. Self-configuration and Auto configuration, Capacity Models, Fairness, Heterogeneous Mesh Networks, Vehicular Mesh Networks.

Text Books

T1. C.S.R. Murthy & B.S. Manoj, "Ad Hoc Wireless Network - Architectures & Protocols". PRENTICE HALL. 2008. ISBN 0-13-147023-X.

Reference Books

R1. F. Zhan.Leonidas Guibas "Wireless Sensor Networks – An information processing approach". Elseveir Inc – 2004. ISBN 1-55860-914-8

R2. H. Edger, D. Calleway "*Wireless Sensor Networks – Architecture and Protocols* ". Auerbach Publications (August 26, 2003) ISBN 0849318238

R3. O.K. Tonguz, G. Ferrari "*Ad Hoc Wireless Network - A Communication-Theoretic Perspective". Wiley Student publication. 2006. ISBN 978-81-265-3204-7*

R4. M.G. Gouda "Elements of Network Protocol Design". Wiley Student Edition. John Wiley & Sons Publication. 2006 ISBN 9812-53-148-3

R5. H. Karl, A. Willig "Protocol and Architectures – for Wireless Sensor Networks". Wiley India Edition. 2005. ISBN 978-81-265-3369-5

R6. C.M. Cordeiro, D.P. Agrawal "Ad hoc and Sensor Networks – Theory and Applications". World Scientific publication. 2011. ISBN 978-93-8226-480-4

F. Lecture Plan:

Lect No	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1)	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	4144.1	NA
2)	Overview of Data Communication, Computer Networks (Wired, Wireless, Ad Hoc)	Recall Concept of Data, Communication & Computer networks	Flipped Classroom	4144.1	Review Assignment In Class Quiz (Not Accounted)
3)	Overview of Computer Networks (Infrastructure & Infrastructure-Less)	Recall Concept of Data, Communication & Computer networks, requirements & implementation	Lecture (ppt)	4144.1	Class Quiz Mid Term I End Term
4)	Introduction to Ad hoc networks & its types, Applications (CH 5, C. Siva Ram Murthy)	Good understanding of organizational structures, way of communication and their effects	Lecture (ppt)	4144.1	Class Quiz Mid Term I End Term
5)	Issues in Ad-Hoc Wireless Networks. (CH 5, C. Siva Ram Murthy)	Relate Issues in data networks & Ad-Hoc Wireless Networks	Lecture (ppt)	4144.1	Home Assignment Class Quiz Mid Term I End Term
6)	Issues in Ad-Hoc Wireless Networks. (CH 5, C. Siva Ram Murthy)	List Issues in Ad-Hoc Wireless Networks	Lecture (ppt)	4144.1	Home Assignment Class Quiz Mid Term I End Term
7)	Issues in Ad-Hoc Wireless Networks. (CH 5, C. Siva Ram Murthy)	Illustrate Issues in Ad-Hoc Wireless Networks	Lecture (ppt)	4144.1	Home Assignment Class Quiz Mid Term I End Term
8)	MAC Protocols: Issues, Classifications of MAC protocols, (CH 6, C. Siva Ram Murthy)	Relate Issues, Classifications of data networks & MAC protocols	Lecture, Activity (Think Pair Share)	4144.2	Home Assignment Class Quiz Mid Term I End Term
9)	MAC Protocols: Issues, Classifications of MAC protocols, (CH 6, C. Siva Ram Murthy)	Illustrate Issues in WAN MAC protocols	Lecture (ppt)	4144.2	Home Assignment Class Quiz Mid Term I End Term
10)	Multi-channel MAC protocol. (CH 6.9, C. Siva Ram Murthy)	Illustrate Issues in Multi-channel WAN MAC protocols	Lecture (ppt)	4144.2	In Class Quiz End Term
11)	Power control MAC protocol. (CH 6.9, C. Siva Ram Murthy)	Illustrate Power control MAC protocol	Lecture (ppt)	4144.2	Class Quiz Mid Term I End Term

12)	Routing Protocols: Issues – Classifications of routing protocols (CH 7, C. Siva Ram Murthy)	Relate Issues, Classifications of data networks & WAN routing protocols	Flipped Classroom	4144.3	Home Assignment Class Quiz Mid Term I End Term
13)	Hierarchical routing protocols (CH 7, C. Siva Ram Murthy)	Illustrate Hierarchical routing protocol	Lecture (ppt)	4144.3	Class Quiz Mid Term I End term
14)	Power aware routing protocols (CH 7, C. Siva Ram Murthy)	Illustrate Power aware routing protocol	Lecture (ppt)	4144.3	Class Quiz Mid Term I End Term
15)	Multicast routing: Classifications, Tree based (CH 8, C. Siva Ram Murthy)	Illustrate Tree based Multicast routing	Lecture+ Activity (Think Pair Share)	4144.3	Class Quiz Mid Term I End Term
16)	Multicast routing: Mesh based (CH 8, C. Siva Ram Murthy)	Illustrate Mesh based Multicast routing	Lecture (ppt)	4144.3	Class Quiz End Term
17)	Ad Hoc Transport Layer: Issues, TCP Over Ad Hoc –Feedback based, TCP with explicit link (CH 9, C. Siva Ram Murthy)	Relate Issues in data networks & Ad-Hoc Transport Layer	Flipped Class+ Lecture+ Activity (Think Pair Share)	4144.4	Class Quiz End Term
18)	TCP with explicit link, TCP-BuS (CH 9, C. Siva Ram Murthy)	Illustrate TCP with explicit link, TCP-BuS	Lecture (ppt)	4144.4	Class Quiz End Term
19)	Ad Hoc TCP, and Split TCP (CH 9, C. Siva Ram Murthy)	Illustrate Ad Hoc TCP, and Split TCP	Lecture (ppt)	4144.4	Home Assignment Class Quiz End Term
20)	Introduction to Wireless Sensor Networks and its applications (CH 12, C. Siva Ram Murthy)	Compare & Contrast data networks, WAN & WSN	Flipped Classroom	4144.5	Home Assignment Class Quiz End Term
21)	WSNs architecture (CH 12, C. Siva Ram Murthy)	Illustrate & Compare data networks & WSNs architecture	Lecture (ppt)	4144.5	Home Assignment Class Quiz End Term
22)	Data dissemination, Gathering (CH 12, C. Siva Ram Murthy)	Illustrate WSN Data dissemination, Gathering	Lecture + Activity (Think Pair Share)	4144.5	Home Assignment Class Quiz End Term
23)	MAC Protocols: self-organizing MAC (CH 12, C. Siva Ram Murthy)	Illustrate WSN self-organizing MAC Protocol	Lecture, activity	4144.5	Home Assignment Class Quiz End Term
24)	MAC Protocols: Hybrid TDMA/FDMA MAC (CH 12, C. Siva Ram Murthy)	Illustrate WSN Hybrid TDMA/FDMA MAC Protocol	Lecture (ppt)	4144.5	Home Assignment Class Quiz End Term
25)	MAC Protocols: CSMA based MAC (CH 12, C. Siva Ram Murthy)	Illustrate WSN CSMA based MAC Protocol	Lecture (ppt)	4144.5	Home Assignment Class Quiz End Term
26)	WSN routing: OLSR (CH 7, C. Siva Ram Murthy)	Illustrate WSN OLSR routing Protocol	Flipped Classroom	4144.5	Home Assignment Class Quiz

					End Term
27)	WSN routing: AODV (CH 7, C. Siva Ram Murthy)	Illustrate WSN AODV routing Protocol	Lecture (ppt)	4144.5	Home Assignment Class Quiz End Term
28)	Localization: Indoor Localization (CH 12, C. Siva Ram Murthy)	Explain need of Localization & Illustrate Indoor Localization	Lecture, activity	4144.6	Class Quiz End Term
29)	Localization: Sensor Network Localization. (CH 12, C. Siva Ram Murthy)	Illustrate Localization	Lecture (ppt)	4144.6	Class Quiz End Term
30)	QoS in WSN, (CH 12, C. Siva Ram Murthy)	Examine the parameters changes in the network environment and observe the change in performance, optimize the behaviour using optimization methods	Flipped Classroom	4144.6	Class Quiz End Term
31)	Introduction to Wireless Mesh Networks and its applications (Notes & PPT)	Relate data networks, WAN, WSN & Mesh networks	Flipped Classroom	4144.6	Class Quiz End Term
32)	Wireless Mesh Networks: Self-configuration (Notes & PPT)	Illustrate Self-configuration in Wireless Mesh Networks	Flipped Classroom	4144.6	Class Quiz End Term
33)	Wireless Mesh Networks: Auto configuration (Notes & PPT)	Illustrate Auto configuration in Wireless Mesh Networks	Flipped Classroom	4144.6	Class Quiz End Term
34)	Wireless Mesh Networks: Capacity Models, Fairness, (Notes & PPT)	Illustrate Capacity Models, Fairness pertaining to Wireless Mesh Networks	Lecture (ppt)	4144.6	Class Quiz End Term
35)	Wireless Mesh Networks: Heterogeneous Mesh Networks, (Notes & PPT)	Illustrate Heterogeneous Mesh Networks	Lecture (ppt)	4144.6	Class Quiz End Term
36)	Wireless Mesh Networks: Vehicular Mesh Networks. (Notes & PPT)	Relate WAN, Mesh & Vehicular Mesh Networks	Lecture (ppt)	4144.6	Class Quiz End Term

G. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 4144.1	Explain the significance and issues with infrastructure-less networks (L2)	1	1	1			1	1					1	3	2	2
EC 4144.2	Illustrate relevant MAC protocol in the context of Ad Hoc networks (L2)	2	3	2										2	2	
EC 4144.3	Illustrate relevant routing protocol in the context of Ad Hoc networks (L2)	2	3	2	2								1			
EC 4144.4	Identify the appropriate TCP mechanism for a given Ad Hoc networks scenario (L3)	2	3	2	2								1	2	3	
EC 4144.5	Select the appropriate data dissemination technique for a given WSNs scenario (L3)	1	2		3									1	2	
EC 4144.6	Illustrate relevant localization mechanism in the context of WSNs (L2)	1	2	1	2									1	2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Dr. Rohit Mathur

(Course Coordinator)

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Information Theory and Coding| EC 4146 | 3 Credits | 3 0 0 3

Session: Aug – Dec. 23 | Faculty: Dr. C.P Gupta | Class: Program Elective

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a Program Elective course, targeting students who wish to pursue research & development in industries or higher studies in field of Information Theory and Coding. This course introduces how various coding takes place in communication and what type of different codes are used in communication system. It also introduces different entropies, channel capacity and purpose of encoding. Students are expected to have background knowledge on Analog and Digital Communication for a better learning.

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

[EC4146.1] Apply the principles of random signal theory to quantify the information and analyze communication system.

[EC4146.2] To study fundamentals of probability, random variable and various statistical analysis Methods.

[EC4146.3] Develop various channel models and apply the skills to analyse different channel for capacity.

[EC4146.4] Apply the Information theory in data compression, transmission and channel encoding, storage and processing, which is also useful in employability.

[EC4146.5] To study & apply various error detection and correction codes.

[EC4146.6] Discuss different codes and their performances use in error control applications.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	15
	Sessional Exam II (Close Book)	15
	In class Quizzes and Assignments , (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Random Signal Theory: Introduction to random variables, discrete and continuous random variables, probability distribution, Cumulative Distribution Function, Joint Distribution, Independent random variable and conditional distribution, Characteristics of random variable: Mean variance and standard deviation, Binomial, Poisson and Normal distributions, Random Processes, Markov Processes. Information Theory: Introduction to information theory and probability, entropy, rate of information, Joint and conditional entropy, Mutual information: noise free channel, channel with independent input and output, Channel capacity: Binary symmetric channel, binary erasure channel, noise free channel, cascaded channels, and binary channel. Coding: Introduction, code efficiency, Shannon theorem, capacity of Gaussian channel, Bandwidth and S/N trade off, Shannon-Fano coding, Huffman coding, LZ coding, Error control coding, Automatic Repeat Request and Forward error correction codes, Block codes and parity check codes, Hamming Weight, Hamming Distance, Minimum distance decoding, Single Parity codes, Hamming Codes, Repetition Codes, Linear block codes, Cyclic code, Convolution code.

F. TEXT BOOKS

- M Kulkarni & K S Shivaprakasha, "Information Theory and Coding", Wiley India Pvt. Ltd, 1st ed.
- R D Singh and S D Sapre, "Communication Systems", 2nd ed., Tata Mcgraw Hill

G. REFERENCE BOOKS

- R. Bose, "Information Theory, Coding and Cryptography", Tata Mcgraw Hill, 2nd ed.
- P. Z. Peebles, Jr., "Probability, Random Variables and Random Signal Principles", McGraw-Hill, Inc., 2nd ed.
- F.M. Reza, "Information Theory", McGraw Hill

H. Lecture Plan:

Lec. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1,2,3	Introduction to random variables, discrete and continuous random variables	Students would get acquainted with basic understanding of the probability and random signal theory.	Lecture	EC4146.1 & EC4146.2	In Class Quiz Mid Term-01
4,5,6	Probability distribution, Cumulative Distribution Function, Joint Distribution	Knowledge of Probability distribution, Cumulative Distribution Function, Joint Distribution	Lecture	EC4146.1 & EC4146.2	In Class Quiz Mid Term-01 End Term
7,8,9	Characteristics of random variable: Mean variance and standard deviation	Students would be able to understand random variable and its characteristics.	Lecture	EC4146.1 & EC4146.2	In Class Quiz Mid Term-01 End Term
10,11,12	Binomial, Poisson and Normal distributions, Random Processes, Markov Processes	Understanding of different distributions and random processes	Lecture	EC4146.1 & EC4146.2	In Class Quiz MidTerm-01 End Term
13,14,15	Information Theory: Introduction to information theory and probability	Understating basics of Information theory	Lecture	EC4146.4	MidTerm-02 End Term
16,17,18	entropy, rate of information, Joint and conditional entropy,	Students would get acquainted with basics of entropy	Lecture	EC4146.3& EC4146.4	MidTerm-02 End Term
19.20,21	Mutual information: noise free channel, channel with independent input and output,	Understanding of Mutual information	Lecture	EC4146.3& EC4146.4	In Class Quiz Mid Term-02 End Term
22,23,24	Channel capacity: Binary symmetric channel, binary erasure channel, noise free channel, cascaded channels, and binary channel.	Knowledge of channel capacity	Lecture	EC4146.3& EC4146.4	In Class Quiz Mid Term-02 End Term
25,26,27	Shannon-Fano coding, Huffman coding	Knowledge of coding theorems and applications	Lecture	EC4146.5	In Class Quiz Mid Term-02 End Term
28,29,30	Code efficiency, Code redundancy, Information channels	Understating Code efficiency, Code redundancy, Information channels	Lecture	EC4146.5	End Term
30,31,31	Probability and Entropy relations in Information channels, Mutual information and properties;	Students will be able to apply probability and entropy in information channels.	Lecture	EC4146.5 & EC4146.6	End Term
32,33,34	Coding: Introduction, code efficiency, Shannon theorem, capacity of Gaussian channel, Bandwidth and S/N trade off	Students would get acquainted with error control codes	Lecture	EC4146.5 & EC4146.6	In Class Quiz End Term
35,36,37	Shannon-Fano coding, Huffman coding, LZ coding, Error control coding, Automatic Repeat Request and Forward error correction codes	Knowledge of various coding techniques and codes	Lecture	EC4146.5 & EC4146.6	In Class Quiz End Term
38,39,40	Hamming Weight, Hamming Distance, Minimum distance decoding, Single Parity codes, Hamming Codes, Repetition Codes, Linear block codes, Cyclic code, Convolution code.	Understanding various error detection and error correction codes	Lecture	EC4146.5 & EC4146.6	In Class Quiz End Term
41	Conclusion and Course Summarization	NA	NA	NA	NA

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 4146.1	Apply the principles of random signal theory to quantify the information and analyze communication system	3	2	1	2	0	0	0	0	0	1	1	1	3	1	1
EC 4146.2	To study fundamentals of probability, random variable and various statistical analysis Methods.	2	3	2	2	0	0	1	1	0	1	0	1	1	2	0
EC 4146.3	Develop various channel models and apply the skills to analyse different channel for capacity	2	2	1	1	0	3	1	0	0	1	1	2	2	1	1
EC 4146.4	Apply the Information theory in data compression, transmission and channel encoding, storage and processing, which is also useful in employbility.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EC 4146.5	To study & apply various error detection and correction codes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EC 4146.6	Discuss different codes and their performances use in error control applications..	2	3	1	2	0	0	0	0	0	1	1	1	2	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Dr C. P. Gupta

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Photonics and Optoelectronics | EC 4147 | 3 Credits | 3 0 0 3

Session: Aug. 2023 – Dec. 2023 | Faculty: Dr. ankur saharia| Class: Program Elective

A. Introduction:

This course comes in the class of program elective subject for the undergraduates. This offered course covers very significant topics of Photonics and Optoelectronics devices. It is a technology of the future. "Photonics is the science of light generation, detection and manipulation through emission, transmission, modulation, signal processing, switching, amplification and sensing". Photonics is the science of using light to generate energy, detect and transmit information and in Optoelectronics we combine the properties of light with the capabilities of microelectronics. The optoelectronic devices convert light to electricity and vice-versa. This course builds on the basic knowledge of both fundamental physics and state-of-the-art technologies for optoelectronic components, to understand their important applications in optical communications and energy conversions that influence our society and everyday life. The course will include the introductions to various physical processes for optical transitions, operation principles of key optoelectronic devices including lasers, photodetectors, modulators and optical sensors, basic functionalities of optical interconnect and signal transmission as well as the basic design consideration for on-chip optical processor and optoelectronic integrated circuits. The objective of the course is to introduce senior-undergraduate students to the field of Photonics and Opto-electronics, thereby helping them to guide their studies and career developments.

B. Course Outcomes:

At the end of the course, students will be able to

[EC4147.1]; Understand fundamental properties of light and operating principles of optical and photonic devices.
[EC4147.2]; Understand modelling to analyse the physics behind semiconductor optoelectronic devices.
[EC4147.3]; Demonstrate in-depth understanding of basic mechanism of Opto-electronic devices, Optical modulators, modulation methods and modulators, transmitters, optical transmitter circuits.
[EC4147.4]; Understand the operating principles, characteristics, and design architectures of display devices.
[EC4147.5]; Understand the operating principles, characteristics and design architectures of photo detectors.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.3]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.4]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.5]. **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

[PO.6]. **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

[PO.7]. **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

[PO.8]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.9]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.10]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.11]. **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

[PO.12]. **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

[PO.13]. **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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	15
	Sessional Exam II	15
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Nature of light, light sources, black body, colour temperature, units of light, radio metric and photometric units, basic semiconductors, PN junction, carrier recombination and diffusion, injection efficiency, heterojunction, internal quantum efficiency, External quantum efficiency, double hetero junction, fabrication of heterojunction, quantum wells and super lattices. Opto-electronic devices, Optical modulators, modulation methods and modulators, transmitters, optical transmitter circuits, LED and laser drive circuits, LED-Power, and efficiency, double heterostructure LED, LED structures, LED characteristics, laser modes, strip geometry, gain guided lasers, index guided lasers. Modulation of light, birefringence, electrooptic effect, EO materials, Kerr modulators, scanning and switching, self-electro optic devices, MO devices, AO devices, AO modulators. Display devices, Photoluminescence, cathode luminescence, EL display, LED display, drive circuitry, plasma panel display, liquid crystals, properties, LCD displays, numeric displays. **Photo detectors**, thermal detectors, photoconductors, detectors, photon devices, PMT, photodiodes, photo transistors**, noise characteristics of photo - detectors, PIN diode, APD characteristics**, APD Design of detector arrays, CCD, Solar cells.

F. TEXTBOOKS

T1. J Wilson and J F B J iS Hawkers, Opto electronics - An introduction, (2e), Prentice-Hall India, 1993.

T2. J M Senior, Optical fibre communication, (3e), Prentice Hall India, 1992.

G. REFERENCE BOOKS

R1. J Gowar, Optical fibre communication systems, (3e),Prentice Hall, 1993.

R2. J. C. Palais, Introduction to optical electronics, (5e), Prentice Hall, 2004.

R3. Jasprit Singh, Semiconductor opto electronics, (1e), McGraw-Hill, Inc, 1995.

R4. P Bhattacharya, Semiconductor optoelectronic devices, (2e), Pearson, 1996.

R5. R. P. Khare, Fibre Optics and Opto-electronics, (1e), Oxford University Press, 2004.

H. Lecture Plan:

Lec. No.	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1,2,	Nature of light, light sources	Students would get conceptual knowledge of optical phenomenon.	Lecture	NA	NA
3,4	black body, color temperature, units of light, radio metric and photometric units,	Knowledge of light sources and light units.	Lecture	4147.1	In Class Quiz Mid Term-01 End Term
5	PN junction, carrier recombination and diffusion	Knowledge of the semiconductor physics.	Lecture	4147.1 & 4147.2	In Home Assignment Mid Term-01 End Term
6	basic semiconductors, PN junction, carrier recombination and diffusion	Understanding about p-n junction mechanism.	Lecture	4147.3	MidTerm-01 End Term
7	injection efficiency, heterojunction, internal quantum efficiency, External quantum efficiency, double hetero junction	Derive the expression for heterojunction internal and external efficiency.	Lecture	4147.3	MidTerm-01 End Term
8-9	fabrication of heterojunction, quantum wells and super lattices	Understanding about quantum wells and super lattices.	Lecture	4147.2	MidTerm-01 End Term
10-12	Opto-electronic devices, Optical modulators, modulation methods and modulators	Understanding of Opto-electronic devices and Optical modulators.	Lecture	4147.3	MidTerm-01 End Term
12-13	transmitters, optical transmitter circuits, LED and laser drive circuits, LED-Power and efficiency, double heterostructure LED, LED structures, LED characteristics	Understand of LED.	Lecture	4147.2	Mid Term-01 End Term
14-15	laser modes, strip geometry, gain guided lasers, index guided lasers.	Understanding of laser characteristics and other properties.	Lecture	4147.3	In Class Quiz End Term
15-16	Modulation of light, birefringence, electrooptic effect, EO materials,	Understanding of material properties.	Lecture	4147.3	Mid Term-01 End Term
17-21	Kerr modulators, scanning and switching, self electro optic devices, MO devices, AO devices, AO modulators.	Understanding of type of devices.	Lecture	4147.4	End Term m
22-24	Display devices, Photoluminescence, cathode luminescence, EL display,	Understanding of type of display devices and working principle.	Lecture	4147.4	End Term
25-29	LED display, drive circuitry, plasma panel display, liquid crystals, properties, LCD displays	Understanding of type of display devices and working principle.	Lecture	4147.4	End Term
30-35	numeric displays. Photo detectors, thermal detectors, photoconductors, detectors, photon devices, PMT	Understanding of type of display devices and photo detectors and working principle.	Lecture	4147.5	End Term
36-38	photodiodes, photo transistors, noise characteristics of photodetectors,	Understanding of photo detectors and working principle.	Lecture	4147.5	End Term
36-39	PIN diode, APD characteristics, APD Design of detector arrays, CCD	Understanding about different type detectors.	Lecture	4147.5	End Term
40	Solar cells.	Understanding about solar cell.	Lecture	4147.5	End Term

End of the session

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 4147.1	Understand fundamental properties of light and operating principles of optical and photonic devices.			3											3	
EC 4147.2	Understand modelling to analyse the physics behind semiconductor optoelectronic devices.	2													3	
EC 4147.3	Demonstrate in-depth understanding of basic mechanism of Opto-electronic devices, Optical modulators, modulation methods and modulators, transmitters, optical transmitter circuits.			3											3	
EC 4147.4	Understand the operating principles, characteristics, and design architectures of display devices.				3										3	
EC 4147.5	Understand the operating principles, characteristics and design architectures of photo detectors.				2	3								2		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Low Power VLSI Design| EC 4152 | 3 Credits | 3 0 0 3

Session: July 23 – Dec 23 | Faculty: Dr. Shilpi Birla| Class: Dep. Elective (VII Sem)

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as an department elective, targeting students who wish to pursue research & development in industries or higher studies in field of Electronics Engineering especially VLSI & Low Power VLSI Design. This course will help the students to understand the concept of VLSI circuit of low power operation, to design various circuits for optimize power. The MOS VLSI Design is the pre-requisite for this course.

B. Course Objectives: At the end of the course, students will be able to

[4152.1] Understand the need of low power design & sources of power dissipation.
[4152.2] Understand the MOS devices and its parametric effects and various power dissipation.
[4152.3] Identify various low power circuit level reduction techniques.
[4152.4] Classify various logic level low power reduction techniques.
[4152.5] Analyse the power & performance management of systems.
[4152.6] Implement the knowledge of low power techniques in designing systems.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.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

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

Program Educational Objectives

- **PEO1**. Graduates will exhibit technical and managerial readiness for electronics, telecommunication and IT industries.
- **PEO2**. Graduates will take up higher studies in niche areas of electronics and communication domain for *the* next level of advancement.
- **PEO3**. Graduates will exhibit productive teamwork in multi-cultural environment.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam	30
	In class Quizzes and Assignments, Activity feedbacks (Accumulated and Averaged)	30
	Laboratory Sessions	
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. Syllabus

Introduction: Need for Low Power design, Sources of power dissipation in Digital Integrated circuits. Emerging low power approaches, Hierarchical Low Power Design Methodologies; Device & technology impact on low power: Physics of power dissipation in CMOS devices, Dynamic and static power dissipation, Transistor sizing & gate oxide thickness. Impact of technology Scaling and Device innovation; Probabilistic power analysis: Random logic signals, probability and frequency, probabilistic power analysis techniques, signal entropy; Circuit level power reduction techniques: Power consumption in circuits. Design of Flip Flops and Latches. Low power digital cell library, Low Power Dynamic logic families and Adiabatic Logic Families. Logic level power reduction techniques: Gate reorganization, pre-computation logic, signal gating, logic encoding, state machine encoding, reduction of power in address and data buses; Low power clock distribution: Power dissipation in clock distribution, Single driver versus Distributed buffers, Zero skew versus Tolerable skew; Low power architecture and systems: Power and performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.

F. Reference Books

R1: G. K. Yeap, "*Practical Low Power Digital VLSI Design*", KAP, 2002.
R2: Rabaey, Pedram, "*Low power design methodologies*" Kluwer Academic, 1997.
R3:K. Roy, Sharat Prasad, "*Low Power CMOS VLSI Circuit Design*" Wiley, 2000.
R4: Kiat, S. Yeo, W. L. Goh, "*CMOS/BiCMOS ULSI Low Voltage Low Power*", Pearson, 2002.

G. Lecture Plan:

Lecture No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction & Overview of the course	Need of the course	Lecture & PPT	NA	NA
2	Need for Low Power design,	Identify the needs of low power circuits in this Electronics world.	Lecture & PPT	4152.1	In Class Quiz Mid Term End Term
3,4,5	Sources of power dissipation in Digital Integrated Circuits-I	Identify different sources of power dissipation in circuits.	Lecture & PPT	4152.1	In Class Quiz Mid Term End Term
6,7	Physics of power dissipation in CMOS devices	Explain the MOS structure and its physics.	Lecture & PPT	4152.1	Home Assignment Mid Term End Term
8,9	Emerging Low Power approaches	Identify new low power approaches.	Lecture & PPT	4152.1	In Class Quiz Mid Term End Term
10	Dynamic Power dissipation	Describe the types of power dissipation in circuits.	Lecture & PPT	4152.2	Class Quiz Mid Term End Term
11	Static Power Dissipation	Explain the static power dissipation.	Lecture & PPT	4152.2	Home Assignment Class Quiz Mid Term End term
12	Transistor sizing & gate oxide thickness.	Recall the sizing effect and thickness effect.	Lecture & PPT	4152.2	Class Quiz Mid Term End Term
13	Impact of technology Scaling and Device innovation	Identify the scaling techniques and it's impact	Lecture & PPT	4152.2	Class Quiz Mid Term End Term
14,15	Power consumption in circuits.	Identify the power consumption in circuits.	Lecture & PPT	4152.2 4152.3	Class Quiz Mid Term End Term
16,17	Circuit level power reduction techniques	Analyse circuit level power reduction techniques.	Lecture & PPT	4152.3	Class Quiz Mid Term End Term
18	Design of Flip Flops and Latches	Describe working of flip flop & latches using low power topologies	Lecture & PPT	4152.3	Class Quiz Mid Term End Term
19,20	Dynamic Logic Families	Analyse the dynamic logic families wrt to Power	Lecture & PPT	4152.3	Class Quiz End Term

21	Gate reorganization structure	Describe the effect of gate reorganization structure	Lecture & PPT	4152.4	Class Quiz End Term
22	Logic Encoding	Illustrate the effect of logic encoding in circuits	Lecture & PPT	4152.4	Class Quiz End Term
23	Encoding Techniques	Explain various coding techniques for low power applications	Lecture & PPT	4152.4	Class Quiz End Term
23	FSM coding	Describe FSM coding which reduces power	Lecture & PPT	4152.4	Class Quiz End Term
24	Numerical Problems	Discussion and analysis of the topics discussed	Lecture & PPT	4152.4	Class Quiz Mid Term II End Term
25	Reduction of power in address and data bus	Describe power reduction in data bus	Lecture & PPT	4152.4	Class Quiz Mid Term II End term
26,27	Switching activity reduction-	Describe how switching activity reduces power	Lecture & PPT	4152.3 4152.5	Class Quiz Mid Term II End Term
28	Power dissipation in clock distribution	Describe clock distribution scheme to reduce power	Lecture & PPT	4152.4	Class Quiz End Term
29	Zero skew versus Tolerable skew	Identify zero skew and tolerable skew	Lecture & PPT	4152.5	Class Quiz End Term
30	Power and performance management	Discuss the power management system and its performance	Lecture & PPT	4152.5	Class Quiz End Term
31	Adiabatic Logic Families	Discuss about Adiabatic logic family	Lecture & PPT	4152.6	Class Quiz End Term
32,33	Design Problems on Adiabatic Logic Families	Discussion and analysis of the topics discussed	Lecture & PPT	4152.6	Class Quiz End Term
34	Parallel architecture with voltage reduction	Discuss how Parallel architecture reduces power.	Lecture & PPT	4152.5	Class Quiz End Term
35	Low power memory design	Discuss low power memory design	Lecture & PPT	4152.6	Class Quiz End Term
36	Design of Low Power systems	Arithmetic systems	Lecture & PPT	4152.6	Class Quiz End Term

H. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 4152.1	Understand the need of low power design & sources of power dissipation	2												2		
EC 4152.2	Understand the MOS devices and its parametric effects and various power dissipation	2	2											2		
EC 4152.3	Identify various low power circuit level reduction techniques	1	1	2										2	2	
EC 4152.4	Classify various logic level low power reduction techniques.	1	1	2										2	2	
EC 4152.5	Analyse the power & performance management of systems	1	2											2	2	
EC 4152.6	Implement the knowledge of low power techniques in designing systems.	2	2	2	1									2	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering Department of Electronics & Communication Engineering

Course Hand-out

Fundamental of Robotics system | EC 4155 | 3 Credits | 3 0 0 3

Session: Jul 23 – Dec 23 | Faculty: Dr. Himanshu Chaudhary| Class: Program Elective

A. Introduction: This is an introductory course in robotics, which comes in the class of program electives for the undergraduates who have had little to no other introductory courses on the topic. The course focuses on topics in robotics that relate to modeling, dynamics, and control of robotic manipulators. Mathematical preliminaries include matrix and vector analysis, basic kinematics and kinetics, and classical (frequency-based) control theory. Some background on more advanced topics such as Lagrangian dynamics, and modern linear and non-linear dynamical system analysis definitely help. The contents of the course are thoughtfully designed, so that students would able to incorporate these concepts into their other courses, where control can be achieved via soft computing implementation in robotics. Students will design and work on robotic systems in a group-based term project.

Most, if not all, course-related communication and material sharing, including class note handouts and occasional videos, will be done through Microsoft Team environment.

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

[4155.1]. Understand and employ various factors of the Mathematical Representation of Robots with their programming examples.

[4155.2]. Analyse and evaluate kinematics of serial and parallel robot manipulator models with their programming examples.

[4155.3]. Learn and implement the velocity analysis and statics of robot manipulators with their programming examples.

[4155.4]. Elaborate and implement the dynamics of robot manipulators with their programming examples.

[4155.5]. Demonstrate the ability to develop robotics-based applications in programming environment for encouraging employability skills.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.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.

[PO.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.

[PO.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.

[PO.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.

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practices.

[PO.9]. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

[PO.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.

[PO.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.

[PSO.1]. To foster the need of understanding the concepts of mathematics, physics and electronics and communication engineering for better realization of existing and upcoming technology.

[PSO.2]. To promote brainstorming through different learning techniques to prepare students for future endeavours.

[PSO.3]. To cultivate the practice of team-work for building interest towards professional and societal connect.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	15
	Sessional Exam II (Close Book)	15
	In class Quizzes and Activity feedbacks plus case-based projects (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Open Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Introduction: Brief History of Robotics, Types of Robots, Technology of Robots, Basic Principles in Robotics. **Mathematical Representation of Robots:** Position and Orientation of a Rigid Body, Transformation Between Coordinate Systems, Representation of Joints, Representation of Links Using Denavit–Hartenberg Parameters, Link Transformation Matrices, examples. **Kinematics of Serial Manipulators:** Degrees of Freedom of a Manipulator, Direct Kinematics of Serial Manipulators, Inverse Kinematics of Serial Manipulators, Manipulator with Non-intersecting Wrist, Inverse Kinematics of a General 6R Robot, Inverse Kinematics for Manipulators With $n < 6$, Inverse Kinematics of Redundant Manipulators, Solution Methods for Non-linear Equations, Examples**. Kinematics of Parallel Manipulators:** Degrees of Freedom, Loop-closure Constraint Equations, Direct Kinematics of Parallel Manipulators, Direct Kinematics of Stewart– Gough Platform, Mobility of Parallel Manipulators, Inverse Kinematics of Parallel Manipulators, Examples. **Velocity Analysis and Statics of Manipulators:** Linear and Angular Velocities of a Rigid Body, Linear and Angular Velocities of Links in Serial Manipulators, Serial Manipulator Jacobian, Parallel manipulator Jacobians, Singularities of Serial and Parallel Manipulators, Statics of Serial Manipulators, Statics of Parallel Manipulators, Singularity in Force Domain, Resolution of Redundancy at Velocity Level, Examples. **Dynamics of Manipulators:** Inertia of a Link, The Lagrangian Formulation, 2R manipulator, Dynamic Equations in Cartesian Space, Inverse Dynamics of Manipulators, Simulation of Equations of Motion, Recursive Formulations of

Dynamics of Manipulators, Newton–Euler Formulation for Inverse Dynamics, Algorithms for Forward Dynamics, Recursive Algorithms for Parallel Manipulators, Examples.

F. TEXT BOOKS

1) A. Ghosal, "Robotics Fundamental Concepts and Analysis", illustrated, OUP India, 2006.
2) R K Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw-Hill Education, 2003.
3) H. Asada, and J. J. Slotine, "Robot Analysis and Control", New York, NY: Wiley, 1986.

G. REFERENCE BOOKS

1) K Sun Fu, Gonzalez, "Robotics- Control, Sensing, Vision, and Intelligence", McGraw-Hill, 2nd edition, 2010.
2) M. Spong, M. Vidyasagar, S. Hutchinson, "Robot Modeling and Control", Wiley & Sons, 2005.
3) J. J. Craig, "Introduction to Robotics: Mechanics and Control", Addison-Wesley Publishing Company, third Edition, 2003.

H. Lecture Plan:

Lec. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1-2	**Introduction:** Brief History of Robotics, Types of Robots, Technology of Robots, Basic Principles in Robotics.	Understand and employ various factors of the Mathematical representation of Robots with their programming examples.	Lecture Microsoft Team followed by activity	4155.1	NA
2-3	**Mathematical Representation of Robots:** Position and Orientation of a Rigid Body, Transformation Between Coordinate Systems, Representation of Joints, Representation of Links Using Denavit–Hartenberg Parameters, Link Transformation Matrices, examples.	Understand and employ various factors of the Mathematical representation of Robots with their programming examples.	Lecture Microsoft Team followed by activity	4155.1	In Class Quiz Mid Term-01 End Term
4-6	**Kinematics of Serial Manipulators:** Degrees of Freedom of a Manipulator, Direct Kinematics of Serial Manipulators, Inverse Kinematics of Serial Manipulators, Manipulator with Non-intersecting Wrist, Inverse Kinematics of a General 6R Robot, Inverse Kinematics for Manipulators With n < 6, Inverse Kinematics of Redundant Manipulators, Solution Methods for Non-linear Equations, Examples.	• Understand and employ various factors of the Mathematical representation of Robots with their programming examples. • Analyse and evaluate kinematics of serial and parallel robot manipulator models with their programming examples.	Lecture Microsoft Team followed by activity	4155.1, 4155.2	In Home Assignment Mid Term-01 End Term Class Project
7-12	**Kinematics of Parallel Manipulators:** Degrees of Freedom, Loop-closure Constraint Equations, Direct Kinematics of Parallel Manipulators, Direct Kinematics of Stewart– Gough Platform, Mobility of Parallel Manipulators, Inverse Kinematics of Parallel Manipulators, Examples.	• Understand and employ various factors of the Mathematical representation of Robots with their programming examples. • Analyse and evaluate kinematics of serial and parallel robot manipulator models with their programming examples.	Lecture Microsoft Team followed by activity	4155.1, 4155.2	In Class Quiz MidTerm-01 End Term Class Project
13-22	**Velocity Analysis and Statics of Manipulators:** Linear and Angular Velocities of a Rigid Body, Linear and Angular Velocities of Links in Serial Manipulators, Serial Manipulator Jacobian, Parallel manipulator Jacobians, Singularities of Serial and Parallel Manipulators, Statics of Serial Manipulators, Statics of Parallel Manipulators, Singularity in Force Domain, Resolution of Redundancy at Velocity Level, Examples.	• Understand and employ various factors of the Mathematical representation of Robots with their programming examples. • Analyse and evaluate kinematics of serial and parallel robot manipulator models with their programming examples. • Learn and implement the velocity analysis and statics of robot manipulators with their programming examples.	Lecture Microsoft Team followed by activity	4155.1, 4155.2, 4155.3	MidTerm-02 End Term Class Project

23-30	**Dynamics of Manipulators:** Inertia of a Link, The Lagrangian Formulation, 2R manipulator, Dynamic Equations in Cartesian Space, Inverse Dynamics of Manipulators, Simulation of Equations of Motion, Recursive Formulations of Dynamics of Manipulators, Newton–Euler Formulation for Inverse Dynamics, Algorithms for Forward Dynamics, Recursive Algorithms for Parallel Manipulators, Examples.	• Understand and employ various factors of the Mathematical representation of Robots with their programming examples. • Analyse and evaluate kinematics of serial and parallel robot manipulator models with their programming examples. • Learn and implement the velocity analysis and statics of robot manipulators with their programming examples. • Elaborate and implement the dynamics of robot manipulators with their programming examples.	Lecture Microsoft Team followed by activity	4155.1, 4155.2, 4155.3, 4155.4	MidTerm-02 End Term Class Project

31-42	Develop robotics-based applications in programming environment.	• Understand and employ various factors of the Mathematical representation of Robots with their programming examples. • Analyse and evaluate kinematics of serial and parallel robot manipulator models with their programming examples. • Learn and implement the velocity analysis and statics of robot manipulators with their programming examples. • Elaborate and implement the dynamics of robot manipulators with their programming examples. • Learn and access trajectory planning and generation of robot manipulator with examples. • Demonstrate the ability to develop robotics-based applications in programming environment for encouraging employability skills.	Lecture Microsoft Team followed by activity	4155.1-4155.6	Class Project

Dr. Himanshu Chaudhary

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

MACHINE LEARNING & AI | EC4156 | 3 Credits | 3 0 0 3

Session: July– Nov 2023| Faculty: Dr. Suddhendu DasMahapatra | Class: B.Tech ECE (VII Sem)

A. Introduction: "Artificial Intelligence and Machine Learning" designed for B.Tech Electronics and Communication Engineering (ECE) students. This course offers a comprehensive and in-depth exploration of the exciting field of Artificial Intelligence (AI) and its prominent subfield, Machine Learning (ML). Artificial Intelligence has emerged as a transformative technology that has the potential to revolutionize various industries and sectors, including healthcare, finance, transportation, and more. The undergraduate ECE students will delve into the fundamental principles, methodologies, and applications of AI & ML, equipping you with valuable skills that are in high demand in today's rapidly evolving world.

B. Course Outcome: At the end of the course, students will be able to

[EC4156.1] Knowledge and Understanding:
demonstrate a comprehensive understanding of the foundational concepts and history of Artificial Intelligence.
[EC4156.2] Application and Analysis:
apply different search strategies, both uninformed and informed, to explore and analyze complex problem spaces effectively.
[EC4156.3] Evaluation and Creation:
evaluate and interpret the results of machine learning algorithms, including supervised and unsupervised learning models, decision trees, and statistical learning techniques.
[EC4156.4] Application and Problem Solving:
apply their knowledge of AI concepts and machine learning techniques to solve practical problems and develop AI-based solutions.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	30
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of	

	absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 3 throughout the entire semester.
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. A student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.

E. Syllabus

Introduction: Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Applications of Artificial Intelligence, Intelligent Agents, Structure of Intelligent Agents. Computer vision, Natural Language Possessing. Introduction to Search : Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning. Knowledge Representation & Reasoning: Propositional logic, Theory of first order logic Inference in First order logic, Forward & Backward chaining, Resolution, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks. Machine Learning : Supervised and unsupervised learning, Decision trees, Statistical learning models, Learning with complete data - Naive Bayes models, Learning with hidden data - EM algorithm, Reinforcement learning. Pattern Recognition : Introduction, Design principles of pattern recognition system, Statistical Pattern recognition, Parameter estimation methods – Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Classification Techniques – Nearest Neighbor (NN) Rule, Bayes Classifier, Support Vector Machine (SVM), K – means clustering.

F. Text Books

T1. Stuart Russell, Peter Norvig, Artificial Intelligence – A Modern Approach, (3e), Pearson Education, 2009

T2. Elaine Rich and Kevin Knight, Artificial Intelligence, (1e), McGraw-Hill,1990.

G. Reference Books

R1. E Charniak and D McDermott, Introduction to Artificial Intelligence, (1e), Pearson Education, 2016.

R2. Dan W. Patterson, Artificial Intelligence and Expert Systems, (1e), Prentice Hall of India, 1990.

H. Lecture Plan:

Lec No	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers' expectations and understand student expectations	Lecture	**EC4156.1**	NA
2	Introduction to Artificial Intelligence	To introduce the concept of AI	Lecture	**EC4156.1**	Class Quiz
3	Foundations and History of Artificial Intelligence	To understand the history of AI	Lecture	**EC4156.1**	In Class Quiz Home Assignment
4	Foundations and History of Artificial Intelligence	To understand the foundation of AI	Lecture	**EC4156.1**	Mid-term End Term Class Quiz
5	Applications of Artificial Intelligence	To know the areas of application of AI	Lecture	**EC4156.2**	In Class Quiz End Term
6	Intelligent Agents	To understand Intelligent Agents	Lecture	**EC4156.1**	Class Quiz Mid Term End Term
7	Structure of Intelligent Agents	To understand Structure of Intelligent Agents	Lecture	**EC4156.1**	Class Quiz Mid Term End term
8	Computer vision, Natural Language Possessing	To understand Computer vision, Natural Language Possessing	Lecture	**EC4156.2**	Home Assignment Class Quiz Mid Term End Term
9	Introduction to Search: Searching for solutions	To introduce searching for solutions	Lecture	**EC4156.1**	Mid Term End Term
10,11	Uniformed search strategies	To understand Uniformed search strategies	Lecture	**EC4156.2**	Class Quiz Mid Term End Term
12,13	Uniformed search strategies	Examples and application	Lecture	**EC4156.2**	Class Quiz Mid Term End Term
14	Informed search strategies	To understand Informed search strategies	Lecture	**EC4156.1**	Class Quiz Mid Term End Term
15,16	Informed search strategies	Examples and application	Lecture	**EC4156.2**	Class Quiz Mid Term End Term

17,18	Informed search strategies	Examples and application	Lecture	**EC4156.3**	Class Quiz Mid Term End Term
19	Local search algorithms	To understand Local search algorithms	Lecture	**EC4156.1**	Class Quiz Mid Term End term
20	Local search algorithms	Examples and application	Lecture	**EC4156.2**	Class Quiz Mid Term End term
21,22	Local search algorithms	Examples and application	Lecture	**EC4156.3**	Class Quiz Mid Term End Term
23	optimistic problems	To understand optimistic problems	Flip Classroom	**EC4156.2**	Class Quiz Mid Term End Term
24,25	Adversarial Search	To understand Adversarial Search	Lecture	**EC4156.2**	Class Quiz Mid Term End Term
26	Search for games	To understand Search for games	Lecture	**EC4156.2**	Class Quiz Mid Term End Term
27,28	Alpha - Beta pruning	To understand Alpha - Beta pruning	Lecture	**EC4156.4**	Class Quiz End Term
29	Knowledge Representation & Reasoning: Propositional logic	To understand Knowledge Representation & Reasoning:	Lecture	**EC4156.3**	Class Quiz End Term
30	Forward & Backward chaining	To understand Forward & Backward chaining	Lecture	**EC4156.3**	Class Quiz End Term
31	Resolution, Probabilistic reasoning	To understand Resolution, Probabilistic reasoning	Lecture	**EC4156.3**	Class Quiz End Term
32,33	Utility theory, Hidden Markov Models (HMM),	To understand Utility theory, Hidden Markov Models (HMM)	Lecture	**EC4156.4**	Class Quiz End Term
34	Bayesian Networks	To understand Bayesian Networks	Lecture	**EC4156.4**	Class Quiz End Term
35	Machine Learning : Supervised and unsupervised learning, Decision trees, Statistical learning models,	To introduce Machine Learning	Flip Classroom	**EC4156.4**	Class Quiz End Term
36	Pattern Recognition : Introduction, Design principles of pattern recognition system, (LDA), Classification Techniques – Nearest Neighbor (NN) Rule, Bayes Classifier, Support Vector	To introduce Pattern Recognition	Flip Classroom	**EC4156.4**	Class Quiz End Term

	Machine (SVM), K – means clustering.				

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC4156.1	demonstrate a comprehensive understanding of the foundational concepts and history of Artificial Intelligence	2	2	1	1									1	1	1
EC4156.2	apply different search strategies, both uninformed and informed, to explore and analyze complex problem spaces effectively.	2	3	2	2									2	2	1
EC4156.3	evaluate and interpret the results of machine learning algorithms, including supervised and unsupervised learning models, decision trees, and statistical learning techniques.	3	3	3	2	1								1	2	1
EC4156.4	apply their knowledge of AI concepts and machine learning techniques to solve practical problems and develop AI-based solutions	3	3	2	2	1								1	2	1
		3	3	3	2	1								2	2	2

Program Outcomes- Competencies-Performance Indicators.

	PO1: Engineering Knowledge: apply knowledge of mathematics, science, engineering. fundamentals and an engineering specialization to the solution of complex engineering problems.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
1.1	Demonstrate competence in mathematical modeling	1.1.1	Apply mathematical techniques such as linear algebra, differential calculus, differential equations and integral calculus to solve problems		Yes	Yes	Yes
1.2	Demonstrate competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem	Yes	Yes	Yes	Yes
1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply engineering fundamentals	Yes	Yes	Yes	Yes
1.4	Demonstrate competence in specialized engineering knowledge to the program	1.4.1	Apply electronics engineering concepts to solve engineering problems		Yes	Yes	Yes

	PO2: 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			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
2.1	Demonstrate an ability to identifyand formulate complex engineering problem	2.1.3	Identify the mathematical, engineering, and other relevant knowledge that applies to a given problem	Yes	Yes	Yes	Yes
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.3	Identify existing solution/methods for solving the problem, including forming justified approximations and assumptions		Yes	Yes	Yes
2.3	Demonstrate an ability to formulate and interpret a model	2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.	Yes	Yes	Yes	Yes
2.4	Demonstrate an ability to execute a solution process and analyze results	2.4.1	Apply engineering mathematics to implement solution.	Yes	Yes	Yes	Yes

	PO3: Design & Development of Solutions: design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
3.1	Demonstrate an ability to define a complex/open-ended problem in engineering terms	3.1.1	Recognize that need analysis is key to good problem definition		Yes	Yes	Yes
		3.1.6	Determine design, objectives, functional requirements and arrive at specifications	Yes	Yes	Yes	
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.3	Identify suitable criteria for evaluation of alternate design solutions			Yes	Yes
3.3	Demonstrate an ability to select optimal design scheme for further development	3.3.1	Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria.	Yes		Yes	

	PO4: Conduct Investigation of Complex Problems: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem for purpose of investigation, its scope and importance	Yes	Yes	Yes	Yes
4.2	Demonstrate an ability to design experiments to solve open ended problems	4.2.1	Design and develop experimental approach, specify appropriate equipment and procedures	Yes	Yes	Yes	Yes
4.3	Demonstrate an ability to analyzedata and reach a valid conclusion	4.3.2	Critically analyze data for trends and correlations, stating possible errors and limitations			Yes	
		4.3.3	Represent data (in tabular and/or graphicalforms) so as to facilitate analysis and explanation of the data, and drawing of conclusions		Yes		

	PO5: Modern Tools Usage: create, select and apply appropriate techniques, resources, andmodern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
5.1	Demonstrate an ability to identify/create modern engineering tools, techniques and resources	5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems			Yes	
5.2	Demonstrate an ability to select and apply discipline specific tools,techniques and resources	5.2.1	Identify the strengths and limitations of toolsfor (i) acquiring information (ii) modeling andsimulating (iii) monitoring system performance, and (iv) creating engineering designs				
		5.2.2	Demonstrate proficiency in using discipline specific tools				
5.3	Demonstrate an ability to evaluatethe suitability and limitations of tools used to solve an engineering problem	5.3.1	Discuss limitations and validate tools, techniques and resources				

	PO6: The Engineer and Society: apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
6.1	Demonstrate an ability to describeengineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1	Identify and describe various engineering roles; particularly as pertains to protection ofthe public and public interest at global, regional and local level.				
6.2	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to professional engineering practice and explain its contribution to the protection of the public.				

	PO7: Environment & Sustainability: understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
7.1	Demonstrate an understanding ofthe impact of engineering and industrial practices on social, environmental and in economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity				
		7.1.2	Understand the relationship between the technical, socioeconomic and environmental dimensions of sustainability				
7.2	Demonstrate an ability to applyprinciples of sustainable designand development	7.2.1	Describe management techniques for sustainable development				
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline				

	PO8: Ethics: apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives				
		8.2.1	Identify tenets of code of ethics given by the professional bodies like IEEE.				
8.2	Demonstrate an ability to applythe code of ethics	8.2.2	Examine and apply moral & ethical principles to known case studies				

	PO9: Individual & Team work: function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team				
9.2	Demonstrate effective individual and team operations--- communication, problem solving,conflict resolution and leadershipskills	9.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills				
9.3	Demonstrate success in a teambased project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts				

	PO10: Communication: communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
10.1	Demonstrate an ability to comprehend technical literature and document project work	10.1.1	Read, understand and interpret technical and non-technical information				
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents				
		10.1.3	Create flow in a document or presentation- alogical progression of ideas so that the main point is clear				
10.3	Demonstrate the ability to integrate different modes ofcommunication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations				

	PO11: Project management & 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			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
11.1	Demonstrate an ability to evaluatethe economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity				
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project				
11.2	Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1	Analyze and select the most appropriate proposal based on economic and financial considerations				
11.3	Demonstrate an ability to plan/manage an engineering activity within time and budgetconstraints	11.3.1	Identify the tasks required to complete an engineering activity and the resources required to complete the tasks				
		11.3.2	Use project management tools to schedule an engineering project so it is completed on time and on budget				

	PO12: Life-long Learning: recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
12.1	Demonstrate an ability to identify gaps in knowledge and a strategyto close these gaps	12.1.1	Describe the rationale for requirement for continuing professional development				
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap				
12.2	Demonstrate an ability to identifychanging trends in engineering knowledge and practice	12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.				
12.3	Demonstrate an ability to identifyand access sources for new information	12.3..2	Analyze sourced technical and popular information for feasibility, viability, sustainability etc.				

	PSO1: An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
13.1	Ability to identify errors in circuits, systems and products	13.1.1	Select and use the suitable tools and methodology for identification of faults	Yes	Yes	Yes	Yes
		13.1.2	Able to locate and classify the fault				
13.2	Ability to rectify faults in circuits,systems and products	13.2.1	Select and use the suitable tools and methodology for rectification of faults	Yes	Yes	Yes	Yes
		13.2.2	Able to eliminate fault with optimum efforts for proper functioning of circuits, systems and products.	Yes			

	PSO2: An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
14.1	Ability to use open source tools	14.1.1	Recognize need of open source tools	Yes	Yes	Yes	Yes
		14.1.2	Identify and use the available open source tool for a given task			Yes	Yes
		14.1.3	Develop or modify open source tool for custom applications	Yes	Yes		

	PSO3: Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur			**CO1**	**CO2**	**CO3**	**CO4**
	Competency	**Performance Indicators**					
15.1	Ability to identify social and environmental awareness	15.1.1	Comprehend literature, carry out background search & prior art, create a flowchart or diagram to bring clarity in invention and summarize the invention.	Yes		Yes	Yes
15.2	Ability to utilize minimum resources	15.2.1	Identify and use the available sources to be utilized for a given task		Yes		
15.3	Ability to have essential features of entrepreneur	15.3.1		Yes			

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Neural Network and Deep Learning | EC 4157 | 3 Credits | 3 0 0 3

Session: Jul 23 – Dec 23 | Faculty: Dr. Himanshu Chaudhary| Class: Program Elective

A. **Introduction:** This course comes in the class of program electives for the undergraduates. This course will cover fundamental concepts used in soft computing related to the neural networks and deep learning. The contents of the course are thoughtfully designed, so that students would able to incorporate these concepts into implementing the deep learning. The concepts of Artificial Neural Networks (ANNs) will be covered first, followed by convolution neural network (CNN) and deep learning. It offers in-depth knowledge of Deep Learning, convolution neural network, RNN, GAN, and popular deep learning architectures. Applications of CNN techniques to solve a number of real-life problems will be covered to have hands on practices. In summary, this course will provide exposure to theory as well as practical systems and software used in neural networks and deep learning.

B. **Course Outcomes:** At the end of the course, students will be able to

EC[4157.1]. Compare and employ various factors of the brain and neuron function with mathematical methods.

EC[4157.2]. Compare, analyse and evaluate various neural network models and their training methods with examples.

EC[4157.3]. Develop artificial neural networks-based applications in MATLAB for encouraging employability skills.

EC[4157.4]. Apply and analyse the popular convolution neural networks (CNN) architectures.

EC[4157.5]. Interpret the concepts of RNN, GAN, Auto encoders.

EC[4157.6]. Experiment and evaluate with applications of deep learning based on neural networks with examples for encouraging development skills and entrepreneurship.

C. **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.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.

[PO.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.

[PO.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.

[PO.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.

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practices.

[PO.9]. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

[PO.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.

[PO.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.

[PSO.1]. To foster the need of understanding the concepts of mathematics, physics and electronics and communication engineering for better realization of existing and upcoming technology.

[PSO.2]. To promote brainstorming through different learning techniques to prepare students for future endeavours.

[PSO.3]. To cultivate the practice of team-work for building interest towards professional and societal connect.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	20
	Sessional Exam II (Close Book)	20
	In class Quizzes/Assignments/MOOC/ Case based projects (Accumulated and Averaged)	20
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Neural Network: Introduction: history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks, supervised learning networks, Associative memory networks, unsupervised learning networks, Special networks like Simulated Annealing Network, Cascade Correlation network, and Optical neural network. Applications of Neural Network.

Deep Learning: Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network. Probabilistic Neural Network: Hopfield Net,

Boltzman machine, RBMs, Sigmoid net, Autoencoders. Deep Learning research: Object recognition, sparse coding, computer vision, natural language processing. Deep Learning Tools: Caffe, Theano, Torch, Matlab.

F. TEXT BOOKS

1) S.N. Deepa, S.N. Sivanandam, "Principles of Soft Computing", Wiley; second edition 2011.
2) S. Jain, "Modelling and Simulation using MATLAB – Simulink", Wiley, 2015.
3) S. Roy, U. Chakraborty, "Soft Computing: Neuro-Fuzzy and Genetic Algorithms", Pearson; first edition, 2013.
4) L. Deng & D. Yu, Deep Learning: Methods and Applications, (1e), Now Publishers, 2014.
5) Goodfellow, Y. Bengio, A. Courville, Deep Learning, (1e), MIT Press, 2016.
6) M. Nielsen, Neural Networks and Deep Learning, (1e), Determination Press, 2015.

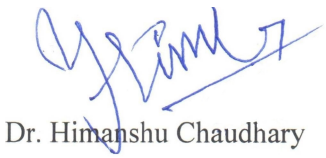
G. REFERENCE BOOKS

1) S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications", PHI, 2013.
2) Satish Kumar, "Neural Networks: A Classroom Approach (1e)", Tata McGraw-Hill Education, 2009.
3) Phil Kim, "MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress, 2017.
4) Taweh Beysolow II, "Introduction to Deep Learning Using R", Apress, 2017.
5) Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer Nature, 2018.

H. Lecture Plan:

Lect. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1	Neural Networks, Application scope of Neural Networks, Fuzzy Logic, Hybrid Systems, Soft Computing.	Distinguish various factors of the brain and neuron function with mathematical methods.	Lecture through PPT/ Board followed by activity	4157.1	Board Presentation
2-3	**Introduction** to Artificial Neural Networks, Fundamental Concepts: ANN (Artificial Neural Network), BNN (Biological Neural Network), Symmetry and comparison between ANN and BNN, Basics of ANN: Connection, Learning and Activation Function, Important terminologies of ANN: Weights, Bias, Threshold, Learning Rate, Momentum Factor, Vigilance Parameter.	• Distinguish various factors of the brain and neuron function with mathematical methods. • Compare, analyse and evaluate various neural network models and their training methods with examples. • Develop artificial neural networks-based applications in MATLAB.	Lecture through PPT/ Board followed by activity	4157.1, 4157.2, 4157.3	In Class Quiz Mid Term-01 End Term
4-6	**Fundamental Models of ANN**: McCulloch-Pitts Neuron Model: Architecture and Working, Hebb Net: Architecture, Algorithm, Linear Separability. Examples.	• Compare, analyse and evaluate various neural network models and their training methods with examples. • Develop artificial neural networks-based applications in MATLAB.	Lecture through PPT/ Board followed by activity	4157.2, 4157.3	In Home Assignment Mid Term-01 End Term Class Project

7-12	**Supervised Learning Networks:** Single layer and Multi-Layer Perceptron Networks, Single layer and Multi-Layer Adaptive Linear Neuron, Back-Propagation Network, Examples.	• Compare, analyse and evaluate various neural network models and their training methods with examples. • Develop artificial neural networks-based applications in MATLAB.	Lecture through PPT/ Board followed by activity	4157.2, 4157.3	In Class Quiz MidTerm-01 End Term Class Project
13-22	**Unsupervised Learning:** Fix Weight Competitive Nets: Max Net, Mexican Hat Net, Hamming Net, Kohonen Self Organising Feature Maps, Learning Vector Quantization, Counter Propagation Net, Adaptive Resonant Theory Net1 and 2, Examples.	• Compare, analyse and evaluate various neural network models and their training methods with examples. • Develop artificial neural networks-based applications in MATLAB.	Lecture through PPT/ Board followed by activity	4157.2, 4157.3	MidTerm-02 End Term Class Project
23-30	**Associative Memory Networks:** Auto associative Memory Net, Heteroassociative Memory Net, Bidirectional Associative Memory Net, Hopfield Net: Discrete, Continuous Type, Iterative Auto associative Memory Net. Examples.	• Compare, analyse and evaluate various neural network models and their training methods with examples. • Develop artificial neural networks-based applications in MATLAB.	Lecture through PPT/ Board followed by activity	4157.2, 4157.3	MidTerm-02 End Term Class Project
31-36	**Convolutional Neural Networks**		Lecture through PPT/ Board followed by activity	4157.4	End Term, Class Project
37-43	**Recurrent Neural Network**		Lecture through PPT/ Board followed by activity	4157.3,4157.4,4157.5, 4157.6	In Class Quiz Mid Term-02 End Term Class Project
	Deep learning applications to computer vision and natural language processing(NLP)				



Dr. Himanshu Chaudhary

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

SYSTEM VERILOG FOR DESIGN & VERIFICATION | EC 4161 | 3 Credits | 3 0 0 3

Session: JUL 23 – DEC 23 | Faculty: Dr. Shilpi Birla| Class: Dep. Elective (VII Sem)

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a department elective, targeting students who wish to pursue research & development in industries or higher studies in field of Electronics Engineering especially VLSI Design. The objective of the course is to provide a thorough understanding about designing of digital circuits & Test bench-based verification using System Verilog. The Digital Electronics & Verilog HDL is the pre-requisite for this course.

B. Course Objectives: At the end of the course, students will be able to

[4161.1] Explain the concepts of System Verilog, the general problems and methods related to literal values and built-in data types.
[4161.2] Apply the System Verilog various literals, datatypes in various circuit.
[4161.3] Make use of array, structures, and unions in designs in System Verilog codes.
[4161.4] Classify System Verilog Procedural Blocks, Tasks and Functions
[4161.5] Modeling Finite State Machines with System Verilog for Digital applications.
[4161.6] Design complex logic components from specifications to synthesizable System Verilog code.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.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

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

Program Educational Objectives

- **PEO1**. Graduates will exhibit technical and managerial readiness for electronics, telecommunication and IT industries.
- **PEO2**. Graduates will take up higher studies in niche areas of electronics and communication domain for *the* next level of advancement.
- **PEO3**. Graduates will exhibit productive teamwork in multi-cultural environment.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam	30
	In class Quizzes and Assignments, Activity feedbacks (Accumulated and Averaged)	30
	Laboratory Sessions	
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. Syllabus

Introduction to System Verilog, System Verilog declaration Spaces, System Verilog Literal Values and Built in Data types: assignments, variables, models. System Verilog user defined data types and enumerated types, Arrays, Structures and Unions. Procedural Blocks, Tasks and Functions. System Verilog Procedural Statements. Modeling FSMs with System Verilog.

Reference Books:

1. Christian B. Spear, System Verilog for Verification: A Guide to Learning the Testbench Language Features, Springer 2012
2. Mark Glasser, Harry Foster, Tom Fitzpatrick, Adam Rose, Dave Rich ,Open Verification Methodology Handbook: Creating Testbenches in System Verilog and SystemC, Morgan Kaufmann, 2009
3. Faisal Haque, Jonathan Michelson, Khizar Khan, The Art of Verification with System Verilog Assertions, , Verification Central, 2006.

F. Lecture Plan:

Lecture No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction to System Verilog		Lecture & PPT	NA	NA
2,3	System Verilog Declaration Spaces-Packages	Understand Package declarations	Lecture & PPT	4161.1	In Class Quiz Mid Term I End Term
4,5	System Verilog Declaration Spaces-Declarations	Understand the coding guidelines	Lecture & PPT	4161.1	In Class Quiz Mid Term I End Term
6,7	System Verilog Declaration Spaces-Units & Precision	To use time units and precisions in coding	Lecture & PPT	4161.2	Class Quiz Mid Term I End Term
7,8	System Verilog Literal Values and Built-in Data Types	To know various data types	Lecture & PPT	4161.2	Home Assignment Mid Term I End Term
9,10	System Verilog variables	To know the use of system variables	Lecture & PPT	4161.2	Class Quiz Mid Term I End Term
11,12	Using 2-state types in RTL models	Learns to know the state type variables	Lecture & PPT	4161.2	In Class Quiz Mid Term I End Term
13,14	Signed and unsigned modifiers	Know the various modifiers	Lecture & PPT	4161.2	Class Quiz Mid Term I End Term
15,16	Static and automatic variables	To understand how to use different type of variables	Lecture & PPT	4161.2	Home Assignment Class Quiz Mid Term I End term
17,18	Deterministic variable initialization	To know Initializing sequential logic asynchronous inputs		4161.2	Class Quiz Mid Term I End Term
19,20	Type casting	Use of type cate and synthesis guidelines		4161.2	Class Quiz Mid Term I End Term
21,22	System Verilog User-Defined types	Know different types of user defined types	Lecture & PPT	4161.3	Class Quiz Mid Term I End Term
23,24	Enumerated Types	Use of enumerated data types		4161.3	Class Quiz Mid Term I End Term

25,26	Unions	Understand Implementation of union	Lecture & PPT	4161.3	Class Quiz Mid Term II End Term
27,28	Arrays	Use of array & unions	Lecture & PPT	4161.3	Class Quiz Mid Term II End Term
29,30	Structures				
31,32	Procedural Blocks	Understand the concept of procedural block	Lecture & PPT	4161.4	Class Quiz Mid Term II End Term
33,34	Enhancements to tasks and functions	Use of Task & function in system verikig	Lecture & PPT	4161.4	Class Quiz Mid Term II End Term
35,36	SystemVerilog Procedural Statements	Know the use of procedural statements	Lecture & PPT	4161.4	Class Quiz Mid Term II End Term
37,38	Modeling Finite State Machines with SystemVerilog	To learn and implement FSM using system verilog	Lecture & PPT	4161.5	Class Quiz Mid Term II End Term
39,40	Implementation of synthesizable code using system Verilog	Implement the theoretical and practical fundamentals, with modern digital design and verification tools	Discussion	4161.6	End Term

G. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 4161.1	Explain the concepts of System Verilog, the general problems and methods related to literal values and built-in data types.	1												2		
EC 4161.2	Apply the System Verilog various literals, datatypes in various circuit.	1												2		
EC 4161.3	Apply System Verilog array, structures, and unions in designs.	1	2											2	2	
EC 4161.4	Make use of array, structures, and unions in designs in System Verilog codes.	1	2											2	2	

EC 4161.5	Modeling Finite State Machines with System Verilog for Digital applications.	1	2	2										2	2	
EC 4161.6	Design complex logic components from specifications to synthesizable SystemVerilog code.	2	2	1	1									2	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Minor Project-II | EC4170 | Credits 01

Session: July – Dec 2023 | Faculty: Dr. Amit Rathi Class: VII semester

A. **Introduction:** This course is offered by Dept. of Electronics and Communication Engineering as in this practical course, in which each student is expected to design and develop practical solutions to real life problems related to industry, institutions and computer science research. The theoretical knowledge, principles and practices gained from various subjects would be applied to develop effective solutions to various computing problems. The knowledge gained to work with various electronic circuits, software tools, designing tools, programming languages, operating systems, etc. would be utilized in various stages of project. The Modeling Techniques, Design and Testing strategies and project outcomes would be part of document of the work. A committee consisting of minimum three faculty members shall perform internal assessment of the minor projects. A report on minor project would be submitted for evaluation, Project work would be presented and demonstrated before the panel of examiners.

B. **Course Outcomes:** At the end of the course, students will be able to

[EC 4170.1] Identify the basics of the concepts related to the selected topic of the project and identify the open issues.

[EC 4170.2] Identify the depth of the problem and to propose the solution to increase the employability.

[EC 4170.3] Solve real time problems related to industry and contribute to open community with ethical values by undergoing systematic study.

[EC 4170.4] Work in team with proper contribution from individuals and managing the project for lifelong learning.

C. **PROGRAM OUTCOMES**

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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.

[PO.5]. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

[PO.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.

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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.

[PO.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.

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Progress I	15
	Progress II	15
	Presentation-I	15
	Presentation-II	15
End Term Exam (Summative)	Final Report	20
	Presentation	20
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

E. Syllabus

To design and present a project related to Electronics and Communication engineering with substantial multidisciplinary component.

The project work may be carried out in institute laboratory. An interim project report on the progress of the work shall be submitted to the department during the mid-term evaluation. The final evaluation and viva-voce will be conducted after submission of the final project report in the prescribed form. Students have to make a presentation on the work carried out, as part of project evaluation.

F. Course Articulation Matrix: (Mapping of COs with POs & PSOs)

CO	STATEMENT	CORRELATION WITH PROGRAMOUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
[EC1680.1]	Identify the basics of the concepts related to the selected topic of the project and also identify the open issues.	**3**	**3**	3	**2**	2	1	1	1	0	0	0	0	**3**	**2**	**2**
[EC1680.2]	To identify the depth of the problem and to propose the solution.	3	**3**	**2**	**2**	2	0	0	0	0	0	1	0	2	3	**2**
[EC1680.3]	Solve real time problems and contribute to open community with ethical values by undergoing systematic study and to communicate the proposed solution.	**2**	**2**	**2**	**2**	**2**			0	0	1	0	0	2	**3**	3
[EC1680.4]	Work in team with proper contribution from individuals and managing the project with lifelong learning.	3	3	3	3	**2**	1	1	0	3	0	1	3	2	2	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Basic Sciences

Department of Mathematics and Statistics

Course Hand-out

Engineering Mathematics IV | MA2217 | 3 Credits | 3 0 0 3

Session: Jan 24 – May 24 | Faculty: Dr. Sunil Joshi| Class: Compulsory

A. **Introduction:** In the first part the student will be acquainted with some basic concept of probability and theorems like total probability theorem, Bayes' theorem, and problems and one two dimensional random variables. In the second part we discuss about the distributions like Binomial, Poisson, Normal, Chi, etc. and sampling distribution. In the third part we discuss about finite differences and its properties and in the last segment we discuss about the application of partial differential equations by using the numerical method.

B. **Course Outcomes:** At the end of the course, students will be able to the student is able to think logically.

[2217.1]. Learn about Basic concept of Probability theory and their applications in engineering.

[2217.2]. Understand the concept of one- and two-dimensional random variables.

[2217.3]. Ability to solve the problems based on correlation and fitting of curve.

[2217.4]. To Learn distribution theory and finite difference equations.

[2217.5]. Learn numerical methods-based solution of partial differential equations and real-life engineering problem solution skill.

PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.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.

[PO.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.

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

[PO.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.

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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.

[PO.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.

[PO.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.

[PSO.1]. To solve complex practical problems related to electrical & electronics engineering applications by applying and correlating the knowledge gained from mathematics, basic sciences and other fundamental courses.

[PSO.2]. To design, develop and analyse the prevalent domains of electrical systems for sustainable, reliable, environmentally friendly and feasible solutions.

[PSO.3]. Develop, investigate and solve different models of electrical networks using modern engineering tools for variety of real time, industrial and research problems.

C. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	30
	In class Quizzes and Assignments, Activity feedback (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

D. SYLLABUS

MA2217: ENGINEERING MATHEMATICS – IV [2 1 0 3]

Probability finite sample space, conditional probability and independence, Bayes theorem, **one dimensional random variable** mean and variance, Chebyshev inequality. Two and higher dimensional random variables, correlation coefficient, Covariance, regression, least square principle of curve fitting.

Distributions binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two-dimensional random variables, Sampling theory, Central limit theorem and applications. **Finite Difference** Difference Calculus, difference equations with constant coefficients, solutions. Finite difference expressions for first and second order derivatives. Solution of boundary value problems, numerical solutions of Laplace and Poisson equations by standard five point formula and heat and wave equations by explicit methods.

E. TEXT BOOKS

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. P. L. Meyer, *Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.

F. REFERENCE BOOKS

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. P. L. Meyer, *Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.

Lec No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Probability	To acquaint students basic concept of probability	Lecture	MA2217.1	In class quiz
2	Basics, review	Recall and learn basics of probability theory	Lecture	MA2217.1	In Class Quiz
3	Conditional probability and total probability theory	Understand the concept of Conditional probability and total probability theory	Lecture	MA2217.1	Home assignment Mid Term I End Term exam
4, 5	Total probability theory and Baye's theorem	Understand the concept-based problems	Lecture	MA2217.1 MA2217.5	Home Assignment Mid Term I End Term exam
6	Random variables	Understand the concept random variable	Lecture	MA2217.2	In Class Quiz End Term
7,8	One dimensional Random variable and problems	Understand the concept-based problems	Lecture	MA2217.2	Class Quiz Mid Term I End Term
9,10	One dimensional Random variable and problems	Understand the concept two dimensional problems	Lecture	MA2217.2	Class Quiz Mid Term I End term
11	mean and variance	Understand the concept of mean and variance and apply to problems	Lecture	MA2217.2	Home Assignment Class Quiz Mid Term I
12	Chebyshev's inequality	Understand the concept of Chebyshev's inequality and apply to problems	Lecture	MA2217.2 MA2217.5	Class Quiz Mid Term I End Term
13,14	Two and higher dimensional random variables	Understand the concept Two and higher dimensional random variables	Lecture	MA2217.2 MA2102.5	Class Quiz Mid Term I End Term
15,16	Problems based on Two and higher dimensional random variables	Understand the concept Two and higher dimensional random variables and apply to real life problems	Lecture	MA2217.2 MA2217.5	Class Quiz End Term
17,18	Correlation and application-based problems	Understand the concept of correlation	Lecture	MA2217.3 MA2217.5	Class Quiz Mid Term II End Term

19	Regression and application-based problems	Understand the concept of Regression	Lecture	MA2217.3	Class Quiz Mid Term II End Term
20	Fitting of curve	Able to solve the problems based on fitting of straight line and parabola	Lecture	MA2217.3 MA2102.5	Class Quiz Mid Term II End Term
21	Binomial, Poisson distribution	Understand the concept of discrete distribution	Lecture	MA2217.4	Class Quiz Mid Term II End Term
22-24	uniform, normal, gamma, chi-square and exponential	Understand the concept continuous probability distributions	Lecture	MA2217.4	Class Quiz End Term
25-26	Functions of one dimensional and two-dimensional random variables,	Able to find the Fourier transform of functions	Lecture	MA2217.2 MA2217.5	Class Quiz End Term
27-28	Sampling theory	Able to find the Sine and cosine transforms of functions	Lecture	MA2217.2 MA2217.5	Class Quiz End Term
29	Central limit theorem and applications	Understand the Basic concepts of PDE	Lecture	MA2217.3	Class Quiz End Term
30-31	difference equations with constant coefficients, solutions.	Able to solve PDE	Lecture	MA2217.3	Class Quiz End Term
32-33	Finite difference expressions for first and second order derivatives	Able to solve PDE	Lecture	MA2217.3	Class Quiz End term
34-36	Solution of boundary value problems, numerical solutions of Laplace and Poisson equations by standard five-point formula and heat and wave equations by explicit methods	Able to solve wave equations	Lecture	MA2217.3	Class Quiz
37	Solution of boundary value problems, numerical solutions of Poisson equations by standard five-point formula and heat and wave equations by explicit methods	Able to solve heat equations	Lecture	MA2217.3	Class Quiz Mid Term II End Term
38	Solution of boundary value problems, numerical solutions of heat and wave equations by explicit methods	Able to solve PDE numerically	Lecture	MA2217.4	Class Quiz End Term
39	Solution of boundary value problems, numerical solutions of wave equations by explicit methods	Able of find the numerical solution of Laplace equations	Lecture	MA2217.4 MA2217.5	Class Quiz End Term

4. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA 2217.1	Learn about Basic concept of Probability theory and their applications in engineering.	3	2	2								1	2	2		2
MA 2217.2	Understand the concept of one- and two-dimensional random variables.	3	3	2	2								3		2	2
MA 2217.3	Ability to solve the problems based on correlation and fitting of curve	3	3	3	2				1				2	2	2	
MA 2217.4	To Learn distribution theory and finite difference equations.	3	3	3	2					1			3	2	2	
MA 2217.5	Learn numerical methods-based solution of partial differential equations and real life engineering problem solution skill.	3	2	3	2	2		2					3	2	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Analog Integrated Circuits & Systems | EC2201 | 3 Credits | 3 0 0 3

Session: January – May 2024| Faculty: Prof. Manish Tiwari | Class: Core Course

A. Introduction: This course Provides in depth knowledge of electronic circuits using operational amplifiers. The course includes design and implementation of electronic circuits based on op-amp (IC 741), timer (IC 555), ADC, DAC and PLL (IC 565). It will help the students to design projects and work in automation and instrumentation industries. Students are expected to have a background knowledge on Network Theory for a better learning.

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

EC2201.1 Study and analyze the pin-diagram, characteristics and all individual blocks of an op-amp for skill development.
EC2201.2 Develop the skills to design various electronic circuits using op-amp applicable in linear domain.
EC2201.3 Study and design of active filters using operational amplifiers.
EC2201.4 Demonstrate the non-linear operation of op-amp and solve various problems in non-linear domain and designing of problems as well.
EC2201.5 Design and applications of 555 Timer IC and various other timing circuits using operational amplifier.
EC2201.6 Study and design various D/A and A/D converters and study phase locked loop IC 565 and voltage controlled oscillator IC 566 and their applications.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Designa component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

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[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Mid Term Examination	30
	In class Quizzes and Assignments , Online Course, Projects, Activity feedbacks (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Open Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Operational amplifiers: Operational amplifier transfer characteristics and frequency response of op-amp, measurement of opamp parameters. Block level representation of Op-amp;

Linear applications of op-amp: voltage to current converter, current to voltage converter, instrumentation amplifier and bridge amplifier.

Active filters: Design and analysis of higher order low pass, high pass, band pass (wide and narrow band) and band elimination (wide and narrow band) and all pass active filters.

Non-linear applications of operational amplifier: rectifiers, peak detector, sample and hold circuit, comparators, window detector, Schmitt trigger, square wave, triangular wave generators, oscillators.

Timer IC: pin details and internal working of 555 IC. Applications: astable multivibrator, monostable multivibrator, Schmitt trigger.

Data converters: Principles and specifications of digital to analog converter (DAC) and analog to digital converters (ADC), binary weighted and R-2R DAC, successive approximation type, counter type and servo tracking type and dual slope ADC.

Phase-locked loop IC 565 and Voltage Controlled Oscillator IC 566: Analysis and applications. IC based voltage regulators and power amplifiers.

F. TEXT BOOKS

1. R.A. Gayakwad, Op-Amps and Linear Integrated Circuits, (4e), Prentice Hall of India, 2002.
2. W. D. Stanley, Operational Amplifiers with Linear Integrated Circuits, (4e), Pearson Education, 2007.
3. F. Sergio, Design with Op amps & Analog Integrated Circuits, (4e), McGraw Hill, 2014.

G. REFERENCE BOOKS

1. K.R. Botkar "Integrated Circuits" Khanna Publishers Delhi.
2. B. Razavi, "Design of Analog CMOS Integrated Circuits", Tata Mc-Graw Hill.
3. A. Holberg; "CMOS analog Circuit Design", OXFORD Unv. Press. 3rd Edition, 2013

H. Lecture Plan:

Lect #	Topics	Session Outcome	Mode of Delivery	Corresponding CO
1.	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA
2.	Introduction to Operational Amplifier IC 741 and its pin diagram.	Describes basics of op-amp 741	Lecture	EC2201.1
3.	Basic bloakc diagram of operational amplifier and its equivalent circuit	Understanding of internal structure of op-amp.	Lecture	EC2201.1
4.	Characteristics and performance parameters of Op-amp	Understanding of various performance parameters of op-amp.	Lecture	EC2201.1
5.	Characteristics of ideal operational amplifier, open loop and closed loop operation of operational amplifier	Understanding open-loop and closed loop operation of Op-amp	Lecture	EC2201.1
6.	Inverting and non-inverting comfiguration of operational amplifier, voltage follower	Describes various configurations of op-amp.	Lecture	EC2201.2
7.	Summing amplifier, buffer, subtractor	Applications of operational amplifier.	Lecture	EC2201.2
8.	Integrator, differentiator.	Understanding of op-amp based Integrator, differentiator circuits.	Lecture	EC2201.2
9.	Voltage to current converter, current to voltage converter.	Understanding of various applications of op-amp.	Lecture	EC2201.2
10.	Difference amplifier.	Describes applications of op-amp as difference amplifier.	Lecture	EC2201.2
11.	Instrumentation amplifier and bridge amplifier.	Describes applications of op-amp as instrumentation amplifier.	Lecture	EC2201.2
12.	Introduction to active filters	Understading active filters, their types and their operaations	Lecture	EC2201.3
13.	Design and analysis of first and higher order low pass, high pass.	Understanding and designingof various filter circuits.	Lecture	EC2201.3
14.	Band pass (wide and narrow band) and band elimination (wide and narrow band)	Understanding of various filter circuits.	Lecture	EC2201.3
15.	All pass active filters	Understanding of various filter circuits.	Lecture	EC2201.3

16.	Precision half wave and full wave rectifier	Describes various applications of op-amp 741.	Lecture	EC2201.4
17.	Peak detector, sample and hold circuit.	Describes various applications of op-amp 741.	Lecture	EC2201.4
18.	Log and antilog amplifiers, analog multipliers and dividers.	Describes various applications of op-amp 741.	Lecture	EC2201.4
19.	Window detector,comparators.	Describes various applications of op-amp 741.	Lecture	EC2201.4
20.	Schmitt trigger, square wave.	Describes various applications of op-amp as a square wave generator.	Lecture	EC2201.4
21.	Triangular wave generators and pulse generator.	Describes various applications of op-amp 741.	Lecture	EC2201.4
22.	Introduction, pin details of 555 I.C., functional diagram of 555 IC.	Understanding of 555 Timer IC.	Lecture	EC2201.5
23.	Astablemultivibrator,	Describes applications of 555 Timer IC.	Lecture	EC2201.5
24.	Positive and negative edge triggered monostablemultivibrator.	Describes applications of 555 Timer IC.	Lecture	EC2201.5
25.	Linear ramp generator and FSK generator.	Describes applications of 555 Timer IC.	Lecture	EC2201.5
26.	Principles of digital to analog converter (DAC) and analog to digital converters (ADC).	Understanding of DAC and ADC using op-amp.	Lecture	EC2201.6
27.	Binary weighted DAC.	Understanding of DAC and ADC using op-amp.	Lecture	EC2201.6
28.	R-2R digital to analog converters.	Understanding of DAC and ADC using op-amp.	Lecture	EC2201.6
29.	Flash type, successive approximation type.	Understanding of DAC and ADC using op-amp.	Lecture	EC2201.6
30.	Counter type and servo tracking type and dual slope analog to digital converters,	Understanding of DAC and ADC using op-amp.	Lecture	EC2201.6
31.	Specifications of ADC and DAC and numericals.	Understanding of DAC and ADC using op-amp.	Lecture	EC2201.6
32.	Functional diagram of voltage controlled oscillator - 566 I.C. and its analysis.	Describes basics of PLL circuits.	Lecture	EC2201.6
33.	Operating principle of PLL, study of IC 565, circuit analysis of phase detector,	Understanding of PLL Circuits and its applications	Lecture	EC2201.6
34.	Definition and derivation for free running frequency, lock range and capture range.	Understanding of PLL Circuits and its applications	Lecture	EC2201.6
35.	Applications of PLL as frequency multiplier, frequency divider, AM and FM demodulation and FSK demodulation	Understanding of PLL Circuits and its applications	Lecture	EC2201.6
36.	Introduction to IC based voltage regulators and power amplifiers	Understaning IC based voltage regulators and power amplifiers	Lecture	EC2201.6

I. Course Outcome Attainment Level Matrix:

CO	STATEMENT	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 40%**												ATTAINMENT OF PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC2201.1	Study and analyze the pin-diagram, characteristics and all individual blocks of an op-amp for skill development.	1	1	0	0	0	0	0	0	0	0	1	1	2	2	0
EC2201.2	Develop the skills to design various electronic circuits using op-amp applicable in linear domain.	3	1	3	2	2	1	2	0	0	2	2	2	3	3	1
EC2201.3	Study and design of active filters using operational amplifiers.	2	2	1	2	2	1	2	0	0	2	2	2	3	3	1
EC2201.4	Analyse environmental impacts of developmental projects and the characteristics of these impacts and hence develop employability skills.	2	1	1	2	1	1	2	0	0	1	2	2	3	3	1
EC2201.5	Design and applications of 555 Timer IC and various other timing circuits using operational amplifier.	3	2	2	3	2	1	2	0	0	2	2	2	3	3	1
EC2201.6	Study and design various D/A and A/D converters and study phase locked loop IC 565 and voltage controlled oscillator IC 566 and their applications.	3	2	2	3	2	1	2	0	0	2	2	2	3	3	1

0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment

MANIPAL UNIVERSITY JAIPUR
School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Microprocessor & Microcontroller | EC 2202 | 4 Credits | 3 1 0 4

Session: Jan – June 2024 | Faculty: Dr. Rohit Mathur| Class: Core Subject

A. Introduction: This course aims to introduce the architecture, programming of microprocessors (8086), interfacing devices and, microcontroller (8051) basic operational procedures. The course incorporates, basic understanding of the device working environment including its basic programming in assembly language. The course gives the conceptual orientation about how programs work and other important parameters involved.

B. Course Outcomes: At the end of the course, students will be able to
[2202.1]. Contrast the internal architecture of microprocessor & microcontroller.
[2202.2]. Explain the operation of various addressing modes of 8086 microprocessor.
[2202.3]. Develop Logical and Conditional assembly language programming skills for 8086 microprocessor.
[2202.4]. Explain how to interface a microprocessor 8086 with peripheral devices.
[2202.5]. Develop assembly C programming skills for 8051 microcontroller.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.
[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using the latest hardware and software tools, along with analytical skills to arrive at cost-effective and appropriate solutions.; and
[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	20
	Sessional Exam II	20
	Assignments Two Quizzes each of 05 marks Software based Assignment	05 10 05
End Term Exam (Summative)	End Term Exam	40
	Total	**100**
Attendance	A minimum of 75% attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments for Academic absence in the class.	Students who miss any assessment procedure will have to report to his/her faculty about the absence (with reason). Respective faculty as per the reason will, (with consent of the course coordinator) decide his/her eligibility for the reassessment. Date and time of the reassessment will be informed with prior notice.	
Homework/ Home Assignment/ Activity Assignment (Formative)	This is flipped classroom activity. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed at the faculty level and might reflect in the internal marks.	

E. SYLLABUS

8086 Microprocessor: Introduction and history of microprocessors and microcontrollers, RISC and CISC Architectures. **8086 Architecture:** Bus Interface Unit and Execution Unit, Instruction pipeline, Data and Address Bus Configuration, Memory Segmentation, Memory Address generation, I/O Port addressing. **8086 Signals:** Functions of all signals, Minimum and Maximum Mode signals, Bus Cycles, Bus Arbitration, Bus driver 8288. Various 8086 Instruction Set and their programming, assembler and assembler directives. **Basic Peripherals and their interfacing with 8086:** Memory interfacing, Interfacing I/O ports, Keyboard/Display Controller, DMA Controller, Multiprocessor Systems. **8051 Microcontroller:** Architectural features, Programming model, I/O Ports, Special Function Registers, Instruction Set and their programming examples.

References:

1. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, *Microprocessors and Microcontrollers,* (1e), Oxford University Press, 2010.
2. K. M . Bhurchandi, A K Ray, *Advanced Microprocessors and Peripheral Devices*, (3e), McGraw Hill Education (India) Private Ltd, 2018.
3. M. A. Mazidi, J. G. Mazidi, R. D. McKinlay, *The 8051 Microcontroller: A Systems Approach*, (1e), Pearson, 2014.
4. D. V. Hall and S. S. S. P. Rao, *Microprocessors and Interfacing*, (3e), McGraw Hill, 2012.

F. Lecture Plan:

Lec. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1,2,3	Introduction and history of microprocessors and microcontrollers, RISC and CISC Architectures	Students would get acquainted with basic understanding of the microprocessors and its developmental stages.	PPT	2202.1	NA
4,5,6	8086 Architecture: Bus Interface Unit and Execution Unit, Instruction pipeline, Data and Address Bus Configuration.	Knowledge of the architectural view of 8086 & it's working principle.	PPT	2202.1	In Class Quiz Mid Term-01 End Term
7,8,9,10	Memory Segmentation, Memory Address generation, I/O Port addressing	Students would be able to understand 8086 memory structure and its operational details.	PPT	2202.1	In Home Assignment Mid Term-01 End Term
11,12,13	8086 Signals: Functions of all signals, Minimum and Maximum Mode signals	Understanding of 8086 mode operations & pin details.	PPT	2202.1	In Class Quiz MidTerm-01 End Term
14,15,16	8086 Instruction Set: Types of Instructions and Addressing Modes	Basic understanding of programming fundamentals.	PPT & Flipped Class	2202.2	MidTerm-02 End Term
17,18,19	Assembler, assembler directives and Programming	Basic understanding of programming instructions	PPT & Flipped Class	2202.3	MidTerm-02 End Term
20,21	Basic Peripherals and their interfacing with 8086	Interfacing concepts	PPT	2202.4	NA
22,23,24	Memory interfacing, Interfacing I/O ports	Interfacing types and fundamentals	PPT & Flipped Class	2202.4	In Class Quiz Mid Term-02 End Term
25,26,27,28	Keyboard/Display Controller	Interfacing device fundamentals	PPT	2202.4	In Class Quiz End Term
29,30	DMA Controller,	Interfacing device fundamentals	PPT	2202.4	End Term
30,31,32	8051 Microcontroller, Architectural features	Interfacing device fundamentals	PPT	2202.1	End Term
33,34	8051 Programming model, I/O Ports, Special Function Registers,	Interfacing device fundamentals	PPT & Flipped Class	2202.5	End Term
35,36,37	8051 Instruction Set	Basics of 8051 Microcontroller	PPT	2202.5	End Term
38,39,40	8051 programming examples	Knowledge of 8051 programming basics	PPT	2202.5	End Term
41,42	8051 Instruction Set	Basics of 8051 Microcontroller	PPT	2202.5	End Term

G. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 2202.1	Contrast the internal architecture of microprocessor & microcontroller.	3														
EC 2202.2	Explain the operation of various addressing modes of 8086 microprocessor.	3	3		2											
EC 2202.3	Develop Logical and Conditional assembly language programming skills for 8086 microprocessor.	3	3	2	3											
EC 2202.4	Explain how to interface a microprocessor 8086 with peripheral devices.	3	2	2	3	1										
EC 2202.5	Develop assembly C programming skills for 8051 microcontroller.	3	3	3	3											

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

DIGITAL SIGNAL PROCESSING | EC 2203 | 4 Credits | 3 1 0 4

Session: Jan– May 2024| Faculty: Dr. Suddhendu DasMahapatra | Class: B.Tech ECE (IV Sem)

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as core Course, targeting students who wish to pursue research & development in industries or higher studies in field of Electronics & Communication Engineering, Including Digital Signal Processing, Image Processing, and Communication Systems. Offers in depth knowledge of DSP by covering Signals, Sampling, Z-Transform, Discrete Fourier transform, Implementation of discrete time systems, Design of IIR filters and digital FIR filters, and Power spectrum estimation for a better learning. Students are expected to have background knowledge on signals & systems for a better learning.

B. Course Outcome: At the end of the course, students will be able to

[EC2203.1] Recall the concepts of signals, systems and Z transform and analysis of signals in time and frequency domain

[EC2203.2] Classify and analyse response of LTI system

[EC2203.3] Relate and apply the concepts of Discrete Fourier Transform to diverse engineering problems

[EC2203.4] Understand and implement discrete time systems such as FIR and IIR structures

[EC2203.5] Acquire the skills to design IIR filters and FIR filters using multiple techniques

[EC2203.6] Understand and interpret frequency domain sampling, signal reconstruction and multi-rate DSP

C. Program Outcomes and Program Specific Outcomes

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam (Closed Book)	30
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of	

	absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 3 throughout the entire semester.
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. A student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.

E. Syllabus

Review of signals and systems: Time and frequency analysis of signals and systems. Transform Analysis of LTI Systems: The frequency Response of LTI systems, Inverse system, All- Pass system, Minimum Phase system, Linear systems with Generalized Linear Phase. Frequency domain sampling and reconstruction of discrete time signals: Discrete-Time Processing of continuous- Time Signals, Continuous- Time Processing of Discrete-Time Signals, Changing the Sampling Rate Using DiscreteTime Processing. Discrete Fourier transform: Introduction, properties of the DFT, use of DFT in linear filtering, filtering of long data sequences, DFT as linear transformation, Computation of DFT, Decimation-in-Time and Decimation–in–frequency Algorithms. Implementation of discrete time systems: Structures for FIR systems – Direct form, cascade form, Frequency sampling and lattice structures. Structures for IIR systems – Direct form, cascade and parallel form. Design of IIR filters and digital FIR filters: Classical design by impulse invariance, bilinear transformation and matched Z- transform, characteristics and design of commonly used filters – butterworth. Chebyshev, elliptical.

F. Text Books

T1. A.V. Oppenheim & R.W. Schafer, Discrete-Time Signal Processing, Pearson education 2003.

T2. S. Salivahanan, C. Gnanpriya, Digital Signal Processing, 2e, Tata McGraw-Hill Education, 2011.

G. Reference Books

R1. J.G. Proakis, D.G. Manolakis, D. Mimitris, Introduction to Digital Signal Processing, Prentice Hall, India 2003.

R2. Sanjit K. Mitra, Digital Signal Processing A Computer Based Approach, 4e, Mc Graw Hill Education, 2013

R3. I. feachar & Jervis, Digital Signal Processing: A Practical approach, Pearson education, Asia, 2003.

R4. L.R. Rabiner & D.J. Gold, Theory and applications of digital signal processing Prentice Hall, India 1988.

R5. Anand Kumar, Signals and Systems, Prentice Hall, India.

R6. Tarun Kumar Rawat, Signals and Systems, Oxford University Press, 2010.

H. Lecture Plan:

Lec No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Review of signals and systems	Recall signal characterization in various domains	Flipped Classroom	2203.1	In Class Quiz
3	Time and frequency analysis of signals and systems	Analyze signals and systems in time and frequency domain	Lecture	2203.1	In Class Quiz Home Assignment
4,5	Transform Analysis of LTI Systems: The frequency Response of LTI systems, magnitude and phase response	Analyze the LTI systems in frequency domain and plot their magnitude and phase response	Lecture	2203.2	Mid-term I End Term In Class Quiz
6,7	Inverse system, All- Pass system,	Define and characterize an inverse system, and all pass system and their relevance	Lecture	2203.2	In Class Quiz End Term
8	Minimum Phase system.	Identify and characterize a minimum-phase system.	Lecture	2203.2	Class Quiz Mid Term I End Term
9,10	Linear systems with Generalized Linear Phase.	Characterize linear systems with linear phase and to identify various types	Lecture	2203.2	Class Quiz Mid Term 1 End term
11,12,13	Discrete Fourier transform: Introduction, properties of the DFT,	To compute the discrete fourier transform of a signal	Flipped Class	2203.3	Home Assignment Class Quiz Mid Term 1 End Term
14	Use of DFT in linear filtering, filtering of long data sequences,	Application of DFT in linear filtering	Lecture	2203.3	Mid Term 1 End Term
15,16	DFT as linear transformation; Computation of DFT,	To compute DFT as a linear transformation	Lecture	2203.3	Class Quiz Mid Term I End Term
17,18	FFT: Decimation-in-Time Fast-fourier transform (DIT-FFT) algorithm and application.	To apply DIT-FFT algorithm for fast computation of DFT(FFT)	Lecture	2203.3	Class Quiz Mid Term I End Term
19,20	Decimation-in-frequency Fast-fourier transform (DIF-FFT) algorithm and application.	To apply DIT-FFT algorithm for fast computation of DFT(FFT)	Flipped Class	2203.3	Class Quiz Mid Term I End Term
21,22	Implementation of discrete time systems: Structures for FIR systems – Direct form, cascade form,	Describe the various structures for implementation of FIR filters- Direct form & cascade form	Lecture	2203.4	Class Quiz Mid Term II End Term

23,24	Structures for FIR systems – Frequency sampling and lattice structures.	Describe the various structures for implementation of FIR filters- Frequency sampling and lattice structures.	Flipped Class	2203.4	Class Quiz Mid Term II End Term
24	Structures for IIR systems – Direct form,	Describe the Direct form structures for implementation of IIR filters.	Flipped Class	2203.4	Class Quiz Mid Term II End term
25,26	Structures for IIR systems – Cascade and parallel form.	Describe the various structures for implementation of IIR filters- Cascade and parallel form.	Flipped Class	2203.4	Class Quiz Mid Term II End term
27	Design of IIR filters: Classical design by impulse invariance,	Design of IIR filters using impulse invariant method	Lecture	2203.5	Class Quiz Mid Term II End Term
28,29	Design of IIR filters: Bilinear transformation and matched Z transform,	Design of IIR filters using Bilinear transformation and matched Z transform,	Flipped Classroom	2203.5	Class Quiz Mid Term II End Term
30,33	Design of FIR filters -characteristics and design of commonly used filters – butter worth, chebychev.	Design of commonly used FIR filters- butter worth, chebychev.	Lecture	2203.5	Class Quiz Mid Term II End Term
34, 35	Frequency domain sampling and reconstruction of discrete-time signals,	To sample a signal in frequency domain and reconstruct it, aliasing	Lecture	2203.6	Class Quiz Mid Term II End Term
36,37	Discrete-Time Processing of continuous- time Signals, Continuous- Time Processing of Discrete-Time Signals ,	Discrete-time processing of continuous-time signals & Continuous- Time Processing of Discrete-Time Signals.	Lecture	2203.6	End Term
38	Decimation and application.	Describe the relevance and process of decimation.	Lecture	2203.6	Class Quiz End Term
39	Interpolation and application.	Describe the relevance and process of interpolation.	Flipped Class	2203.6	Class Quiz End Term
40-42	Changing the Sampling Rate Using Discrete-Time Processing.	Describe the changing of sampling by a non-integer factor(I/D)	Lecture	2203.6	Class Quiz End Term

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC2203.1	Recall the concepts of signals, systems and Z transform and analysis of signals in time and frequency domain	3	2	1	1									2	2	2
EC2203.2	Classify and analyse response of LTI system	2	3	1	2									1	2	1
EC2203.3	Relate and apply the concepts of Discrete Fourier Transform to diverse engineering problems	3	3	3	2	1								1	2	1
EC2203.4	Understand and implement discrete time systems such as FIR and IIR structures	2	3	1	1									1	2	1
EC2203.5	Acquire the skills to design IIR filters and FIR filters using multiple techniques	3	1	1	1									1	2	1
EC2203.6	Understand and interpret frequency domain sampling, signal reconstruction and multi-rate DSP	2	2	1	1	1								1	2	1
	EC2203	3	3	3	2	1								2	2	2

Program Outcomes- Competencies-Performance Indicators.

	PO1: Engineering Knowledge: apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
1.1	Demonstrate competence in mathematical modeling	1.1.1	Apply mathematical techniques such as linear algebra, differential calculus, differential equations and integral calculus to solve problems	Yes	Yes	Yes	Yes	Yes	Yes
1.2	Demonstrate competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem	Yes		Yes		Yes	
1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply engineering fundamentals	Yes	Yes	Yes	Yes	Yes	Yes
1.4	Demonstrate competence in specialized engineering knowledge to the program	1.4.1	Apply electronics engineering concepts tosolve engineering problems	Yes	Yes	Yes	Yes	Yes	Yes

	PO2: 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			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
2.1	Demonstrate an ability to identifyand formulate complex engineering problem	2.1.3	Identify the mathematical, engineering andother relevant knowledge that applies to a given problem	Yes	Yes	Yes	Yes	Yes	Yes
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.3	Identify existing solution/methods for solving the problem, including forming justified approximations and assumptions	Yes	Yes	Yes	Yes	Yes	Yes
2.3	Demonstrate an ability to formulate and interpret a model	2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematicalor otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.	Yes	Yes	Yes	Yes		Yes
2.4	Demonstrate an ability to executea solution process and analyze results	2.4.1	Apply engineering mathematics to implement solution	Yes	Yes	Yes	Yes		

	PO3: Design & Development of Solutions: design solutions for complex engineering problems anddesign 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.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
3.1	Demonstrate an ability to define a complex/open-ended problem in engineering terms	3.1.1	Recognize that need analysis is key to good problem definition		Yes	Yes	Yes	Yes	Yes
		3.1.6	Determine design, objectives, functional requirements and arrive at specifications	Yes	Yes	Yes			
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.3	Identify suitable criteria for evaluation of alternate design solutions			Yes	Yes	Yes	Yes
3.3	Demonstrate an ability to select optimal design scheme for further development	3.3.1	Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria.	Yes		Yes			

	PO4: Conduct Investigation of Complex Problems: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem for purpose of investigation, its scope and importance	Yes	Yes	Yes	Yes	Yes	Yes
4.2	Demonstrate an ability to design experiments to solve open ended problems	4.2.1	Design and develop experimental approach, specify appropriate equipment and procedures	Yes	Yes	Yes	Yes	Yes	Yes
4.3	Demonstrate an ability to analyzedata and reach a valid conclusion	4.3.2	Critically analyze data for trends and correlations, stating possible errors and limitations			Yes			
		4.3.3	Represent data (in tabular and/or graphicalforms) so as to facilitate analysis and explanation of the data, and drawing of conclusions		Yes				

	PO5: Modern Tools Usage: create, select and apply appropriate techniques, resources, andmodern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
5.1	Demonstrate an ability to identify/create modern engineering tools, techniques and resources	5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems			Yes			Yes
5.2	Demonstrate an ability to select and apply discipline specific tools,techniques and resources	5.2.1	Identify the strengths and limitations of toolsfor (i) acquiring information (ii) modeling andsimulating (iii) monitoring system performance, and (iv) creating engineering designs						
		5.2.2	Demonstrate proficiency in using discipline specific tools						
5.3	Demonstrate an ability to evaluatethe suitability and limitations of tools used to solve an engineering problem	5.3.1	Discuss limitations and validate tools, techniques and resources						

	PO6: The Engineer and Society: apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
6.1	Demonstrate an ability to describeengineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1	Identify and describe various engineering roles; particularly as pertains to protection ofthe public and public interest at global, regional and local level.						
6.2	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to professional engineering practice and explain its contribution to the protection of the public.						

	PO7: Environment & Sustainability: understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
7.1	Demonstrate an understanding ofthe impact of engineering and industrial practices on social, environmental and in economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity						
		7.1.2	Understand the relationship between the technical, socioeconomic and environmental dimensions of sustainability						
7.2	Demonstrate an ability to applyprinciples of sustainable designand development	7.2.1	Describe management techniques for sustainable development						
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline						

	PO8: Ethics: apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives						
		8.2.1	Identify tenets of code of ethics given by the professional bodies like IEEE.						
8.2	Demonstrate an ability to applythe code of ethics	8.2.2	Examine and apply moral & ethical principles to known case studies						

	PO9: Individual & Team work: function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team						
9.2	Demonstrate effective individual and team operations--- communication, problem solving,conflict resolution and leadershipskills	9.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills						
9.3	Demonstrate success in a teambased project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts						

	PO10: Communication: communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
10.1	Demonstrate an ability to comprehend technical literature and document project work	10.1.1	Read, understand and interpret technical and non-technical information						
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents						
		10.1.3	Create flow in a document or presentation- alogical progression of ideas so that the main point is clear						
10.3	Demonstrate the ability to integrate different modes ofcommunication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations						

	PO11: Project management & 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			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
11.1	Demonstrate an ability to evaluatethe economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity						
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project						
11.2	Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1	Analyze and select the most appropriate proposal based on economic and financial considerations						
11.3	Demonstrate an ability to plan/manage an engineering activity within time and budgetconstraints	11.3.1	Identify the tasks required to complete an engineering activity and the resources required to complete the tasks						
		11.3.2	Use project management tools to schedule an engineering project so it is completed on time and on budget						

	PO12: Life-long Learning: recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
12.1	Demonstrate an ability to identify gaps in knowledge and a strategyto close these gaps	12.1.1	Describe the rationale for requirement for continuing professional development						
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap						
12.2	Demonstrate an ability to identifychanging trends in engineering knowledge and practice	12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.						
12.3	Demonstrate an ability to identifyand access sources for new information	12.3..2	Analyze sourced technical and popular information for feasibility, viability, sustainability etc.						

	PSO1: An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
13.1	Ability to identify errors in circuits, systems and products	13.1.1	Select and use the suitable tools and methodology for identification of faults	Yes	Yes	Yes	Yes	Yes	Yes
		13.1.2	Able to locate and classify the fault						
13.2	Ability to rectify faults in circuits,systems and products	13.2.1	Select and use the suitable tools and methodology for rectification of faults	Yes	Yes	Yes	Yes	Yes	Yes
		13.2.2	Able to eliminate fault with optimum efforts for proper functioning of circuits, systems and products.	Yes					

	PSO2: An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
14.1	Ability to use open source tools	14.1.1	Recognize need of open source tools	Yes	Yes	Yes	Yes	Yes	Yes
		14.1.2	Identify and use the available open source tool for a given task			Yes	Yes	Yes	Yes
		14.1.3	Develop or modify open source tool for custom applications	Yes	Yes				

	PSO3: Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur			**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
	Competency	**Performance Indicators**							
15.1	Ability to identify social and environmental awareness	15.1.1	Comprehend literature, carry out background search & prior art, create a flowchart or diagram to bring clarity in invention and summarize the invention.	Yes		Yes	Yes	Yes	Yes
15.2	Ability to utilize minimum resources	15.2.1	Identify and use the available sources to be utilized for a given task		Yes				
15.3	Ability to have essential features of entrepreneur	15.3.1		Yes					

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Electronic Sub-System Design Lab| EC2230| 1 Credits | 0 0 2 1

Session: Jan 24 – May 24 | Faculty: Dr. Neha Singh/Dr Shilpi Birla | Class: IV sem Lab course

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a Lab course in IV semester. The course aims to help the students understand practical use and implementation of the theoretical concepts of operational amplifiers and Timer IC. The students are required to work with op-amp and timer IC based circuits to expose them to practical feasibility, capability and limitations of these IC regarding their best utilization in a specific situation.

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

[2230.1] Understand and analyse the characteristics of an op-amp.
[2230.2] Apply the knowledge of op-amp to design various electronic circuits in linear domain.
[2230.3] Understand the non-linear operation of op-amp and solve various problems in non-linear domain and designing of problems as well.
[2230.4] Apply knowledge of Timer IC 555 to develop circuits for projects, employability and entrepreneur skills.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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.

[PO.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.

[PO.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.

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.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.

[PO.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.

[PO.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.

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Each lab experiment is evaluated for performance, lab record maintenance and knowledge based on viva during the entire semester.	60
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Lab sessions (Formative)	A student who misses a class will have to report to the teacher about the absence. He/ She has to perform the experiment issued on the missed date in extra time during the same week. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence for the week. If the student fails to carry out the experiment in the same week, he will be marked absent with penalty of one mark for attendance in evaluation.	
Lab record	The students need to maintain lab-records of the experiment they carry out in the lab. It is expected from the student that he completes the experiment details in the record within the week of issue of the experiment and get it corrected in the next lab-class itself. Delay in submission of work attracts penalty of marks.	

E. SYLLABUS

Experiments of this lab are implemented at Hardware as well as software level. The circuits based on op-amp and Timer IC are performed.

F. TEXT BOOKS

Not Applicable

G. REFERENCE BOOKS

[1] R. L. Boylestad & L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 2009

[2] S. Salivahanan and N Suresh Kumar, "Electronics Device and circuits", McGraw Hill Publication, 2010

H. Lecture Plan:

Lab No.	Name of the experiment	Experiment Outcome	Type of Expt	Corresponding CO	Mode of Assessing the Outcome
1	(a) Design and implement an inverting amplifier using op-amp 741 for the given gain. (b) Design and implement a non-inverting amplifier using op-amp 741 for the given gain.	To design amplifier using op-amp	Hands-on	EC2230.1 EC2230.2	Observational Data, Viva-Voce
2	(a) Implement a voltage follower circuit using op-amp 741 and calculate its voltage gain. (b) Design and implement a summing amplifier (adder circuit) for at least three inputs using op-amp 741 for the given gain.	To use op-amp as voltage follower and design adder circuit	Hands-on	EC2230.2	Observational Data, Viva-Voce
3	(a) Design and implement a scaler circuit using op-amp 741. (b) Design and implement an averager circuit using op-amp 741 for the given gain.	To design an average and scalar circuit using op-amp	Hands-on	EC2230.2	Observational Data, Viva-Voce
4	(a) Design and implement a difference amplifier circuit using op-amp 741 for the given gain. (b) Design and implement a comparator using op-amp 741 and verify the output.	To design difference amplifier and comparator using op-amp	Hands-on	EC2230.2	Observational Data, Viva-Voce
5	Design and implement an integrator using op-amp 741 and verify the output for the given waveshapes: (i) triangular (ii) square (iii) sinusoidal.	To design integrator using op-amp	Software	EC2230.2	Observational Data, Viva-Voce
6	Design and implement a differentiator using op-amp 741 and verify the output for the given waveshapes: (i) triangular (ii) square (iii) sinusoidal.	To design differentiator using op-amp	Software	EC2230.2	Observational Data, Viva-Voce
7	(a) Design and implement a second order Butterworth Low Pass Filter using op-amp 741 for the given cut-off frequency and obtain its frequency response. (b) Design and implement a second order Butterworth High Pass Filter using op-amp 741 for the given cut-off frequency and obtain its frequency response.	To design filters using op-amp	Hands-on	EC2230.3	Observational Data, Viva-Voce
8	Design and implement a Butterworth Band Pass Filter using op-amp 741 for the given cut-off frequencies and obtain its frequency response.	To design filters using op-amp	Software	EC2230.3	Observational Data, Viva-Voce
9	Design a Schmitt Trigger using op-amp 741 and verify its output.	To design Schmitt trigger using op-amp	Software	EC2230.3	Observational Data, Viva-Voce
10	Design and implement a square wave generator using op-amp 741 forgiven frequency.	To design a generator using op-amp	Software	EC2230.3	Observational Data, Viva-Voce
11	Design and implement Astable Multivibrator using Timer IC 555 for the given time period.	Design AMV using IC 555	Hands-on	EC2230.4	Observational Data, Viva-Voce
12	Design and implement Monostable Multivibrator using Timer IC 555 for the given pulse width.	Design MMV using IC 555	Software	EC2230.4	Observational Data, Viva-Voce

Additional Experiments					
13	Design and implementation of a Phase shift oscillator using IC 741.	Design oscillator using op-amp	Software	EC2230.3	Observational Data, Viva-Voce
14	Implement a log and antilog amplifier using IC 741.	Op-amp non-linear applications	Software	EC2230.3	Observational Data, Viva-Voce

A. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
2230.1	Understand and analyse the characteristics of all individual blocks of an op-amp.	2	1	0	0	0	0	0	0	0	0	0	0	3	0	0
2230.2	Apply the knowledge of op-amp to design various electronic circuits in linear domain.	0	0	3	3	0	0	0	0	3	0	0	0	3	1	0
2230.3	Understand the non-linear operation of op-amp and solve various problems in non-linear domain and designing of problems as well.	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0
2230.4	Understand the principle and applications of Phase Locked Loop in various modulation techniques	0	0	3	0	0	0	0	0	3	0	2	0	3	1	0

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Dr Shilpi Birla **Dr Neha Singh**

MANIPAL UNIVERSITY JAIPUR
School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Microprocessor Laboratory | EC 2232 | 1 Credits | 0 0 2 1

Session: Jan – May 2024 | Faculty: Dr. Rohit Mathur| Class: Lab Course

A. Introduction: This course aims to introduce the architecture, programming of microprocessors (8086). The course incorporates, basic understanding of the device working environment including its basic programming in assembly language. The course gives the conceptual orientation about how programs work, other important parameters involved.

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

[EC2232.1]. Describe the function and purpose of each instruction & assembler directive of 8086 microprocessor & 8051 microcontroller,

[EC2232.2]. Explain the operation of each instruction with applicable addressing modes,

[EC2232.3]. Develop Logical and Conditional assembly language programming skills for 8086 microprocessor.

[EC2232.4]. Develop Logical and Conditional assembly language programming skills for 8051 microcontroller.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.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

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Networks, Communication Systems, Signal processing, VLSI, Embedded systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Laboratory Sessions (2 hrs/week)	60
End Term Assessment (Summative)	Lab Exam Performance (3 hrs ETE)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the Practical End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a lab session will have to report to the teacher about the absence. The missed experiment can be performed as a makeup experiment in the next lab session or anytime before the laboratory exam.	
Laboratory Guidelines	Students are expected to maintain an observation book and a laboratory record notebook. The experimental data should be noted in the observation book on the day of performance and the same should be transferred to the record notebook before the next lab. No students are allowed to enter the lab without the observation book and record book and attendance will be marked absent.	

E. Syllabus

8086 Microprocessor: Introduction to microprocessors and microcontrollers. 8086 Architecture. Assembly Language Programming, 8086 Instruction Set and programming constructs, assembler and assembler directives. Introduction to EMU8086.

8051 microcontroller: 8051 Architecture. C Language Programming, 8051 Instruction Set and introduction to Keil.

F. Reference Books

1. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, Microprocessors and Microcontrollers, (1e), Oxford University Press, 2010.
2. K. M . Bhurchandi, A K Ray, Advanced Microprocessors and Peripheral Devices, (3e), McGraw Hill Education (India) Private Ltd, 2018.
3. D. V. Hall and S. S. S. P. Rao, Microprocessors and Interfacing, (3e), McGraw Hill, 2012.

G. Lecture Plan:

Lab No	Name of the Experiment	Session Outcome	CO Mapping	Mode of Assessing the Outcome
1.	Introduction to 8086	To acquaint and clear teachers expectations and understand student expectations To understand the instruction set and apply to solve the problem	2232.1	Viva-Voce
2.	Write an assembly language program (WALP) to add two bytes available in memory and store the result in the memory. Using sequential program structure.	To understand sequential program structure To use appropriate instructions to solve the problem	2232.2	Observational Data, Viva-Voce
3.	WALP to subtract two 16 bit (word) data available in memory and store the result in the memory. Using sequential program structure.	To understand sequential program structure To use appropriate instructions to solve the problem	2232.2	
4.	WALP for case conversion (A → a). Using if-then program structure.	To understand if-then program structure To use appropriate instructions to solve the problem	2232.3	
5.	WALP to multiply two single ASCII digits available in memory and store the result in unpacked BCD form in memory. Using sequential program structure.	To understand sequential program structure To use appropriate instructions to solve the problem	2232.3	
6.	WALP to divide two 8-bit numbers available in memory and store the result in the memory. Using sequential program structure.	To understand sequential program structure To use appropriate instructions to solve the problem	2232.3	
7.	WALP to find the number of positive and negative data elements present in a given array of ten signed	To understand repeat-until program structure	2232.3	

	hexadecimal numbers stored in memory. Using Repeat-Until structure.	To use appropriate instructions to solve the problem		
8.	WALP to exchange corresponding elements of two data blocks of length 10-bytes stored in memory starting from 0100H and 0120H respectively.	To use appropriate program structure To use appropriate instructions to solve the problem	2232.3	
9.	WALP to search whether the given number 77h is present in a sequence of memory location or not. If it is present then, store "1111h", otherwise "ffffh" in DX.	To use appropriate program structure To use appropriate instructions to solve the problem	2232.3	Observational Data, Viva-Voce
10.	WALP to find number of times letter 'e' appears in the string 'exercise', store the count in memory.	To use appropriate program structure To use appropriate instructions to solve the problem	2232.3	
11.	WALP to find smallest number from the ten elements of a given array of 2-digit hex numbers. using SUBROUTINE.	To use subroutine appropriately To use appropriate instructions to solve the problem	2232.3	
12.	WALP to arrange the given array of 8-bit numbers stored in the memory in ascending order.	To use appropriate program structure To use appropriate instructions to solve the problem	2232.3	
13.	Write a 8051 assembly C program on Keil for addition of two numbers	To use appropriate instructions to solve the problem	2232.4	Observational Data, Viva-Voce
14.	Write a 8051 assembly C program on Keil to find the number of even and odd data elements present in a given array of ten numbers stored in memory. Using loop structure.	To use appropriate instructions to solve the problem	2232.4	
15.	Write a 8051 assembly C program on Keil to find largest number from the ten elements of a given array of numbers. Using functions.	To use appropriate program structure To use appropriate instructions to solve the problem	2232.4	

H. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
2232.1	Describe the function and purpose of each instruction & assembler directive of 8086 microprocessor & 8051 microcontroller	3														
2232.2	Explain the operation of each instruction with applicable addressing modes	3	3	2												
2232.3	Develop Logical and Conditional assembly language programming skills for 8086 microprocessor	3	3	2	2	3										
2232.4	Develop Logical and Conditional assembly language programming skills for 8051 microcontroller	3	2	2	2	2										

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Microwave Engineering | EC 3201 | 3 Credits | 3 0 0 3

Session: Jan 2024 – May 2024 | Faculty: Dr. Dinesh Yadav | Class: Core Subject

A. **Introduction:** This course comes in the class of core subject for the undergraduates targeting who wish to pursue research & development in industries or higher studies in field of Microwave Engineering. Offers in depth knowledge of microwave transmission line analysis, electromagnetic field analysis inside a waveguide, microwave generators, scattering parameter analysis of microwave components and microwave devices. Students are expected to have background knowledge on electromagnetics for a better learning.

B. **Course Outcomes:** At the end of the course, students will be able to

[EC3201.1]. Recall the concepts and fundamentals of electromagnetic field theory
[EC3201.2]. Understand the concepts of guided structures like transmission line and apply the concepts to calculate various parameters of transmission Line using Smith Chart
[EC3201.3]. Explain different types of waveguides and their respective modes of propagation
[EC3201.4]. Understand the working of ferrite and non-ferrite based microwave passive components and apply knowledge to form scattering matrix
[EC3201.5] Understand the performance of specialized microwave tubes such as klystron, reflex klystron, magnetron and Travelling wave tube
[EC3201.6] Recognize the limitations of existing vacuum tubes and understand the operation of solid state devices at various microwave frequencies

C. **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

[PO.1]. **Engineering knowledge:** Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions:** Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.5]. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

[PO.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

[PO.7]. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO 3] Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam (1hr. 30 Min)	30
	Quizzes and assignments Weekly/ bi-monthly Online Course Research Paper Review Research Project Semester-long Hackathon MOOC courses on the SWAYAM/NPTEL In class Quizzes, courses (online or offline), platforms (with passing certificate), long term hackathons, Activity feedback (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Introduction to Transverse Electric, Transverse Magnetic and Transverse Electromagnetic waves in conducting planes, characteristics of TE, TM and TEM waves, wave impedance, attenuation, TE, TM and TEM waves. Transmission line equations & solutions, reflection and transmission coefficient, standing wave and standing wave ratio, line impedance and admittance, impedance matching, using stub line, application of smith chart in solving transmission line problems. Rectangular and circular waveguides-theory and analysis, characteristics of TE and TM mode and excitation of wave guides. Passive components: Resonators, Directional Couplers, E-plane Tee, H-plane Tee and Hybrid Tee, Hybrid ring, Attenuators, Circulator, Faraday rotation principle, Isolators. Microwave active Devices: Limitations of conventional vacuum tube devices. Two cavity klystron: Re-entrant cavities, velocity modulation process, bunching process. Reflex klystron: Velocity modulation, power output and efficiency and electronic admittance. Traveling wave tube: Slow wave structure, amplification process, convection current, axial

electric field, wave modes and gain consideration. Magnetron: Mode of oscillation, Types of Magnetron, Strapping and Rising Sun Magnetron. Microwave diodes and transistors: Tunnel diode, Varactor diode, Gunn diode, IMPATT diode, Microwave transistors and FETs.

F. TEXT BOOKS

1) S. Y. Liao, Microwave Devices and Circuits, Prentice Hall, 2004.

2) D. M. Pozar, Microwave Engineering, John Wiley & Sons, 2004.

G. REFERENCE BOOKS

1) J. Ryder, Network lines and Fields, Prentice Hall, 1999.

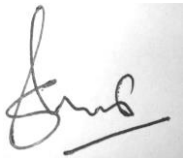
2) Jordan & Balmain, Electromagnetic waves and Radiating System, Prentice Hall, 1968.

H. Lecture Plan:

Lec No	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1	Introduction and Course Hand-out briefing	To acquaint and clear teachers expectations and understand student expectations	Lecture	NA	NA
2	Recall the fundamentals of electromagnetic field theory,	Describes the fundamentals of transmission line	Lecture	3201.1	In Class Quiz
3	Introduction of Transmission Line and Characteristic impedance,	Understanding of line parameters	Lecture	3201.2	In Class Quiz
4	Transmission lines at high frequencies	Understanding of the operation of line at high frequency	Lecture	3201.2	Home Assignment In Class Quiz End Term
5	Reflection coefficient, standing waves on transmission line for different loads,	Understanding of line parameters	Lecture	3201.2	In Class Quiz
6	SWR, eighth, quarter and half wave line, impedance matching	Understanding of line parameters	Lecture	3201.2	Class Quiz Mid Term I End Term
7	Smith chart: Construction single and double stub matching;	Describes smith chart and measurement of unknown parameters	Lecture	3201.2	Home Assignment Class Quiz Mid Term I End Term
8	Guided waves: Transverse electric,	Describes applications of wave guides and its propagation modes	Lecture	3201.3	Class Quiz Mid Term I End Term Home Assignment
9	Transverse magnetic	Describes applications of wave guides and its propagation modes	Lecture	3201.3	Class Quiz Mid Term I End Term
10	Transverse electromagnetic waves in conducting planes	Describes applications of wave guides and its propagation modes	Lecture	3201.3	Class Quiz Mid Term II End Term Home Assignment
11	Characteristics of TE TM and TEM waves	Describes characterises various modes	Lecture	3201.3	Class Quiz Mid Term II End Term Home Assignment
12	wave impedance, attenuation;	Describes various guide parameters	Lecture	3201.3	Class Quiz Home Assignment

13	Rectangular wave guides: TE, TM and TEM waves in rectangular wave guide,	Describes various rectangular wave guide and its modes	Lecture	3201.3	Class Quiz Home Assignment
14	circular wave guides: TE, TM and TEM waves in circular wave guide	Describes various circular wave guide and its modes	Lecture	3201.3	Class Quiz Mid Term II End Term Home Assignment
15	characteristics of TE and TM mode and excitation of wave guides;	Describes modes characterises and excitation modes in waveguide	Lecture	3201.3	Class Quiz Mid Term II End Term Home Assignment
16	Strip lines and micro strip lines: Characteristic impedance, losses and quality factor Q of micro strip lines,	Describes various planer lines and their transmission parameters	Lecture	3201.3	Class Quiz Mid Term II End Term Home Assignment
17	Coplanar strip lines and shielded strip lines	Describes various planer lines and their transmission parameters	Lecture	3201.3	Class Quiz Home Assignment
18	Strip line parameters and its properties;	Describes various planer lines and their transmission parameters	Lecture	3201.3	Mid Term II End Term Home Assignment
19	Passive components: Resonators, Directional Couplers,	Understanding of microwave components	Lecture	3201.4	Mid Term II End Term Home Assignment
20	E-plane Tee, H-plane Tee	Understanding of microwave components	Lecture	3201.4	Class Quiz Mid Term II End Term Home Assignment
21	Hybrid Tee,	Understanding of microwave components	Lecture	3201.4	Class Quiz Mid Term II End Term
22	Hybrid ring, Attenuators,	Understanding of microwave components	Lecture	3201.4	Home Assignment
23	Circulator, Faraday rotation principle,	Understanding of microwave components	Lecture	3201.4	Mid Term II End Term Home Assignment
24	Isolators, Gyrators, Phase Shifters, their applications;	Understanding of microwave components	Lecture	3201.4	Class Quiz End Term
25	Microwave active Devices: Limitations of conventional vacuum tube devices;	Understanding of microwave active devices	Lecture	3201.5	Class Quiz Home Assignment End Term
26	Two cavity klystron: Reentrant cavities,	Understanding of microwave two cavity klystron generators	Lecture	3201.5	Mid Term II End Term Home Assignment
27	Velocity modulation process	Describes velocity modulation process in microwave signal generator	Lecture	3201.5	Mid Term II End Term Home Assignment
28	Bunching process, output power and beam loading;	Understanding of signal generator parameters	Lecture	3201.5	Class Quiz Mid Term II End Term
29	Reflex klystron: Velocity modulation,	Describes of microwave single cavity generator	Lecture	3201.5	Class Quiz Mid Term II End Term Home Assignment

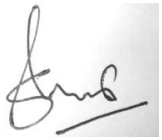
30	Power output and efficiency and electronic admittance;	Understanding of signal generator parameters	Lecture	3201.5	Class Quiz Mid Term II End Term Home Assignment
31	Traveling wave tube: Slow wave structure,	Understanding of TWT and slow wave structures	Lecture	3201.5	Class Quiz Mid Term II End Term
32	Amplification process, convection current,	Understanding of TWT parameters	Lecture	3201.5	Class Quiz Mid Term II End Term Home Assignment
33	Axial electric field, wave modes and gain consideration;	Understanding of TWT parameters	Lecture	3201.5	Class Quiz Mid Term II End Term Home Assignment
34	Magnetron: Mode of oscillation,	Understanding of Magnetron signal generator	Lecture	3201.5	Class Quiz Mid Term II End Term
35	Strapping and Rising Sun Magnetron;	Describes various types of magnetron	Lecture	3201.5	Class Quiz Mid Term II End Term Home Assignment
36	Parametric amplifiers: Physical structure, nonlinear reactance	Understanding of magnetron parameters	Lecture	3201.6	Class Quiz Mid Term II End Term Home Assignment
37	Manley Rowe relations, applications;	Understanding of magnetron parameters	Lecture	3201.6	Class Quiz Mid Term II End Term
38	Microwave diodes and transistors: Tunnel diode	Understanding of diodes and transistor at high frequency	Lecture	3201.6	Class Quiz End Term Home Assignment
39	Varactor diode, Gunn diode	Understanding of diodes and transistor at high frequency	Lecture	3201.6	Class Quiz End Term Home Assignment
40	IMPATT diode	Understanding of IMPATT diodes at high frequency	Lecture	3201.6	Class Quiz End Term Home Assignment
41	Microwave transistors and FETs	Understanding of transistor and FETs at high frequency	Lecture	3201.6	Class Quiz End Term Home Assignment



A. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC3201 .1]	Recall the concepts and fundamentals of electromagnetic field theory	1												1		
[EC3201 .2]	Understand the concepts of guided structures like transmission line and apply the concepts to calculate various parameters of transmission Line using Smith Chart	2	2		1			1		1			1	1	2	
[EC3201 .3]	Explain different types of waveguides and their respective modes of propagation	1	2					1		1				1	2	
[EC3201 .4]	Understand the working of ferrite and non-ferrite based microwave passive components and apply knowledge to form scattering matrix	1						1						1		
[EC3201 .5]	Understand the performance of specialized microwave tubes such as klystron, reflex klystron, magnetron and Travelling wave tube	1			1			1		1			1	1	2	
[EC3201 .6]	Recognize the limitations of existing vacuum tubes and understand the operation of solid state devices at various microwave frequencies	1	2		1			1					1	1		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation



MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication

Department of Electronics & Communication Engineering

Course Hand-out

EMBEDDED & REAL TIME OPERATING SYSTEMS | EC 3202 | 4 Credits | 3 1 0 4

Session: January 24 – May 24 | Faculty: Dr. Abhishek Shrivastava| Class: Dep. Core (6th Sem)

A. Introduction: This course aims to provide the students with knowledge and understanding of Embedded, Operating, and Real-Time Systems. The course focuses on developing related programming skills of the students to make them employable in Embedded & IoT industries.

B. Course Objectives: On successful completion of this course, students shall be able to

[EC 3202.1] Outline the concepts of embedded systems design and analysis.

[EC 3202.2] Understand the concepts of interrupt handling and communication interface protocols in embedded systems.

[EC 3202.3] Outline the concepts of Operating systems in Embedded systems.

[EC 3202.4] Explain the basic concepts of real time operating system design

[EC3202.5] Model real-time applications using embedded-system concepts

C. Program Outcomes (POs) and Program Specific Outcomes (PSOs)

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

Program Specific Outcomes

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	**MTE** Exam (close book)	30
	CWS- Online quizzes + Online course+ Case Study	10+10+10=30
End Term Exam (Summative)	End Term Exam (as per directions)	40 (80 scaled down to 40)
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves. (as per Academic policy 13/06/2019)	
Homework/ Home Assignment/ Activity Assignment (Tutorials) (Formative)	Student is expected to participate and perform in online assignments given via MS team with full zeal timely submission of the assignment. The participation by a student will be assessed and marks will be awarded.	

E. Syllabus

Embedded Systems: Introduction, Classification, Elements of Embedded Systems, Hardware units, devices, Software, Embedded SOC (System on Chip), Design Process, Process of Embedded system development. Interrupts, Devices and Device Drivers: Interrupts, Interrupt Handling Mechanism, Interrupt Controllers, Interrupt Latency, Timers, Counters, Device Drivers. Buses and Communication Interfaces and protocols. **Operating System**: Process Management: Processes, Threads, Process Synchronization, Process Scheduling, Deadlock. Inter-process Communication and synchronization of processes, threads and tasks: Semaphores, Synchronization with semaphores and Mutex, Shared data, Signal function, Message function, Mailbox, Pipe. **Real Time Operating Systems (RTOS):** Introduction, Classification, Services, Process Management, Timer function, Memory Management, Task Scheduling modules, Interrupt latency.

F. Reference Books

- Rajkamal, *Embedded Systems: Architecture, Programming and Design*, (2e), McGraw Hill publication, 2008.

- Frank Vahid, Tony Givargis, *Embedded System Design: A unified Hardware/Software approach*, (3e), John Wiley and Sons, 2009.
- 3. Abraham Silberschaltz, Peter Baer Galvin, Greg Gagne, *Operating System Concepts*, (9e), John Wiley and Sons, 2013.

G. Lecture Plan:

Lec. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO/(s)/POs	Mode of Assessing the Outcomes
1	**Introduction** to Embedded Systems:	Students would get acquainted with basic understanding of the Embedded Systems.	PPT/Board Teaching	3202.1/PO.1/PSO.1	In Class Quiz Mid Term-01 End Term
2-5	Classification, Elements of Embedded Systems, Hardware units, devices, Software, Embedded SOC (System on Chip),	Students get acquainted with various design components of Embedded systems.	PPT/Board Teaching	3202.1/PO.1/PSO.1	In Class Quiz Mid Term-01 End Term
6-9	Design Process, Process of Embedded system development.	Students would learn about the design process involved in development of Embedded systems.	PPT/Board Teaching	3202.1/PO.1/PSO.1	In Class Quiz Mid Term-01 End Term
10-13	Interrupts, Interrupt Handling Mechanism, Interrupt Controllers, Interrupt Latency	Interrupts and handling of interrupts in Embedded systems	PPT/Board Teaching	3202.2/PO.1/PSO.1	In Class Quiz MidTerm-01 End Term
13-15	Timers/Counters in Embedded systems	Timing and counting mechanism in embedded systems	PPT/Board Teaching	3202.1/PO.1/PSO.1	In Class Quiz MidTerm-01 End Term
14,15	Buses and Communication Interfaces and protocols	Students would be able to understand the Communication concepts in Embedded systems.	PPT/Board Teaching	3202.1/PO.1/PSO.1	In Class Quiz MidTerm-01 End Term
16-22	Operating System, Process Management: process concepts, process scheduling, operations on processes and Inter-Process Communications (IPC)	Students would be able to understand the concept of operating systems and associated phenomena	PPT/Board Teaching	3202.3/PO.1/PSO.1	In Class Quiz End Term
22-25	Threads: overview, multicore programming, multithreading models, thread libraries, implicit threading and threading issues.	Students would be able to understand the concept of Threads in operating systems and associated phenomena	PPT/Board Teaching	3202.3/PO.1/PSO.1	In Class Quiz Mid Term-01 End Term
25-28	Process Synchronization, background, mutex locks, semaphores, and critical problems.	Students would be able to understand the concept of Synchronization in operating systems and associated phenomena	PPT/Board Teaching	3202.3/PO.1/PSO.1	In Class Quiz MidTerm-02 End Term
28-31	Deadlocks system models, characterization, methods of handling the deadlocks, preventions, avoidance, detections, and recovery	Students would be able to understand the concept of deadlocks in operating systems and associated phenomena	PPT/Board Teaching	3202.3/PO.1/PSO.1	In Class Quiz MidTerm-02 End Term
31- 35	Real Time Operating Systems (RTOS): Introduction, Classification, Services, Process Management, Timer function, Memory Management, Task Scheduling modules, Interrupt latency.	Students would be able to understand the concept of RTOS systems and associated phenomena	PPT/Board Teaching	3202.4/3202.5/PO.1/PSO.1	In Class Quiz MidTerm-02 End Term

H. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC 3202.1]	Outline the concepts of embedded systems design and analysis.	3		1										3		
EC 3202.2]	Understand the concepts of interrupt handling and communication interface protocols in embedded systems.	3	3	2			2				1			3		2
EC 3202.3]	Outline the concepts of Operating systems in Embedded systems	3	3	3	3	3				2	1	1	1	2	3	1
EC 3202.4]	Explain the basic concepts of real time operating system design	3	3	3	2	1				1				3	2	
EC 3202.5]	Model real-time applications using embedded-system concepts	3		2	2									3		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Dr. Abhishek Shrivastava

Course Coordinator

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

OPTICAL COMMUNICATION | EC3203 | 4 Credits | 3 1 0 4

Session: Jan-May 2024 | Faculty: Dr. Amit Rathi | Class: Compulsory (Core)

A. **Introduction:** The course is aimed at equipping undergraduate Engineering students with the basic understanding of optical fibers and optical fiber communication. The course provides knowledge of optical fiber waveguides at the fundamental level, essentials of an optical fiber communication system and understanding of various components of an optical fiber telecommunication system.

B. **Course Outcomes:** At the end of the course, students will be able to :

[3203.1] Understand basic laws of optical physics for lifelong learning and encouraging entrepreneurship. Distinguish between the various modes of operation of Optical fibres.
[3203.2] Identify the various causes for signal degradation. Calculate the various types of losses occurring in transmission of energy.
[3203.3] Learn and Classify the construction and characteristics of optical sources and their various performance parameters .
[3203.4] Develop the experimental skills needed for optical fibre communication with learn the operation of optical detectors, optical receiver and their noise analysis.
[3203.5] Calculate the link budget analysis for performance analysis and hence result in scope of entrepreneurship.
[3203.6] Understand the use of analogue and digital links. Describe the various criteria viz. power loss wavelength, SNR, BER analysis, EYE-diagram to be considered for point-to-point link system and power penalty.

C. **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

[PO.1]. **Engineering knowledge:** Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	30
	Quizzes and assignments *Weekly/ bi-monthly* Online Course Research Paper Review Research Project Semester-long Hackathon MOOC courses on the SWAYAM/NPTEL In class Quizzes, courses (online or offline), platforms (with passing certificate), long term hackathons, Activity feedback (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Makeup Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Introduction to optical communication: Basic principles of light propagation, Propagation of Light in an Optical Fiber: Ray Model, Numerical aperture, phase-front (wavefront) based study of Total Internal Reflection, Wave Model and its Analysis, V number of an Optical fiber. **Signal distortion on optical Fibers:** Material Dispersion, Intermodal Dispersion, Intermodal Dispersion, Material Attenuation, Microbending, Macrobending, Analysis of Signal distortion in optical fibers using OTDR, Practical issues in implementation of fiber link**. Optical Sources:** Introduction of Optical sources. Light Emitting Diode: Quantum Efficiency, material, electrical and spectral characteristics, modulation. Lasers: Introduction to Laser, Spontaneous

emission, Absorption, Stimulated emission, Different type of lasers: ruby laser, He-Ni laser, semiconductor laser**. Optical Receiver:** Photon detector, Photo Diodes, Photo detector and its noise Analysis, Optical Receiver, Digital data transmission in optical domain, SNR, BER analysis, Performance Analysis and the EYE-diagram, Receiver Sensitivity Degradation, Fiber Optic link Design, power penalty.

F. Text books/ Reference books:

1. G.P Agrawal , "*Fiber optics communication"*, third edition, John Wiley & sons,2002 .

2. Keiser, "*Optical Fiber Communication"*, fourth edition, Mc Graw Hill, 2017.

3. M.N. Islam (Ed), "*Raman Amplifiers for communications"*, Springer-verlag, New York, 2003.

4. J.Senior, "Optical Communication, Principles and Practice", Prentice Hall of India, 3rd Edition, 2008.

A. Lecture Plan:

Lec No	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1,2	Introduction: History of fiber optic communication	Interaction with students and give basic about subject	Lecture	EC3203.1	NA
2,3,4,5	Elements of an optical fibre communication system	Describes basics	Lecture	EC3203.1	In Class Quiz Mid Term I End Term
6,7,8,9	Optical fiber, the nature of light, basic optical laws and definitions	Understanding of nature and laws of optical fibre	Lecture	EC3203.1	In Class Quiz Mid Term I End Term
10,11,12,13	fiber types, step index and graded index fiber, overview of modes, key modal concepts, single mode fiber, mode field diameter,	Understanding of various type of fiber	Lecture	EC3203.2	Home Assignment In Class Quiz End Term
14,15	Optical fiber modes, v-number	Understanding of field propagation	Lecture	EC3203.2	In Class Quiz
16, 17,18,19,20,21	Signal degradation in optical fiber: Fiber losses, dispersion, distortion, design optimization principles.	Understanding about losses in fibre and communication through fiber	Lecture	EC3203.2	Class Quiz Mid Term I End Term Home Assignment
22,23,24,25	Optical sources and detectors: LED, structure of LED, LED materials, types of LEDs,	Understanding of various optical source and its principle	Lecture	EC3203.3	Class Quiz
26,27,28,29, 30	LASER, principle of LASER, structure of LASER diode and radiation pattern, Different type of lasers: ruby laser, He-Ni laser, semiconductor laser	Understanding of various optical source and its principle	Lecture	EC3203.3	Home Assignment Class Quiz Mid Term 1 End Term
31,32,33,34	Photon detector, Photo Diodes, Photo detector and its noise Analysis,	Understanding of various optical detector and its principle	Lecture	EC3203.4, EC3203.5	Class Quiz Mid Term 1 End Term Home Assignment
35,36,37,38,39	Optical Receiver, Digital data transmission in optical domain, SNR, BER analysis	Understanding of optical receiver, SNR, BER.	Lecture	EC3203.4, EC3203.5	Class Quiz Mid Term I End Term
40,41,42,43,44	Performance Analysis and the EYE-diagram, Receiver Sensitivity Degradation, Fiber Optic link Design, power penalty.	Understanding of EYE diagram and power penalty of link design.	Lecture	EC3203.4, EC3203.5	Class Quiz Mid Term II End Term Home Assignment

G. Course Outcome Attainment Level Matrix:

CO	STATEMENT/JUSTIFICATION	ATTAINMENT OF PROGRAM OUTCOMES **THRESHOLD VALUE: 40%**												ATTAINMENT OF PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[3203.1]	Understand basic laws of optical physics for lifelong learning and encouraging entrepreneurship. Distinguish between the various modes of operation of Optical fibres.	3	3	1	1	1	1	1	1	0	0	0	1	2	1	1
[3203.2]	Identify the various causes for signal degradation. Calculate the various types of losses occurring in transmission of energy.	3	3	1	1	1	1	1	1	0	0	0	1	2	1	1
[3203.3]	Learn and Classify the construction and characteristics of optical sources and their various performance parameters.	3	3	3	2	1	1	0	0	0	1	0	2	2	2	1
[3203.4]	Develop the experimental skills needed for optical fibre communication with learn the operation of optical detectors, optical receiver and their noise analysis.	3	3	3	2	2	1	0	0	0	1	0	2	3	2	3
[3203.5]	Calculate the link budget analysis for performance analysis and hence result in scope of entrepreneurship..	2	3	3	2	3	2	1	1	2	2	3	3	3	3	2
[3203.6]	Understand the use of analogue and digital links. Describe the various criteria viz. power loss wavelength, SNR, BER analysis, EYE-diagram to be considered for point-to-point link system and power penalty.	3	2	3	3	3	3	2	1	1	2	1	2	3	3	2

0-No Attainment; 1- Low Attainment; 2- Moderate Attainment; 3- Substantial Attainment

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO1	3	3	3	1	3	1	1	1	0	0	0	1	3	3	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO2	3	3	1	1	1	1	1	1	0	0	0	1	3	1	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO3	3	3	3	2	1	1	0	0	0	1	0	3	3	2	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	3	3	3	2	2	1	0	1	0	1	0	2	3	2	3
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO5	3	3	3	3	3	2	1	1	2	3	3	3	3	1	3
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO6	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Avg	3.00	2.83	2.67	2.00	2.17	1.50	1.00	1.17	0.83	1.33	1.00	2.17	3.00	2.00	2.00

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Embedded & RTOS Lab EC 3230 | 1 Credits | 0 0 2 1

Session: Jan 2024– May 2024 | Faculty: Dr Abhishek Shrivastava

| Class: Core Laboratory Course

A. Introduction: An embedded and RTOS lab involves Real Time Embedded Systems (RTES), which includes microprocessors, micro-controllers or DSP based embedded systems, that not only deliver correct results but also deliver immediately when these results are recorded.

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

[EC3230.1] Identify and describe various characteristics features and applications of embedded systems.
[EC3230.2] Analyze and identify hardware for embedded system implementation.

[EC3230.3] Analyze and identify various software issue involved in embedded system for real time requirement.
[EC3230.4] Apply concepts of Real Time Operating Systems using Shell script/C/C++ and implement real time kernel objects using RTOS "uC-OS/II"(Analysis)
[EC3230.5] Analyze and explain the design life cycle for embedded system implementation.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. **Engineering knowledge:** Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system**.**

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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.

[PO.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.

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

D. List of Experiment:

S. No.	Experiment List	COs
1.	Write a program to blink LED using Intel Galileo Kit.	[3230.1]/ [3230.2]
2.	Write a program to read room temp. From temp. Sensor and glow led if temp. is greater than 25^0 C using Intel Galileo Kit.	[3230.1] / [3230.2]
3.	Write a program to read soil moisture and interface red and blue led using Intel Galileo Kit.	[3230.1] / [3230.2]
4.	Write a program to glow LED whenever a push button is pressed using Intel Galileo Kit.	[3230.1] / [3230.2]
5.	Design the circuit and write a program to count the number of times a push button is pressed and after 5 such instance glow the LED must glow using Galileo Kit.	[3230.1] / [3230.2]
6(a)	Write a program in shell script to find greatest of 3 number numbers input by user.	[3230.1]/[3230.2]/ [3230.4]
6(b)	Write a program in shell script to find whether the number is even or odd.	[3230.1] / [3230.2]/ [3230.4]
6(c)	Write a program to find the factorial of a number.	[3230.1] / [3230.2] / [3230.4]
7(a)	Write a program in shell script to generate Fibonacci Series up to 10th term.	[3230.1] / [3230.2] / [3230.4]
7(b)	Write a program in shell script to swap **numbers input by user**	[3230.1]/ [3230.2]/ [3230.4]
8(a)	Write a program in shell script to perform various arithmetic calculations	[3230.1]/ [3230.2]/ [3230.4]
8(b)	Write a program in shell script for pattern generation.	[3230.1]/ [3230.2]/ [3230.4]
9.	Write a program in embedded c to transfer 8 bytes of data from one controller to PC Using RS232 Communication.	[3230.3]
10	Write a program in embedded c to write on Location 0X0A 24C02 EPROM using I2C Communication.	[3230.3]
11	Write a program in embedded c to interface CS5460 ADC using SPI Communication	[3230.3]
12	Write a driver for Graphical LCD (128 * 64) to display an image on LCD.	[3230.1]/ [3230.2]/ [3230.4]
13	Write a program to design an interrupt controller which can handle 5 interrupts on its pin by using only a single interrupt of the main processor.	[3230.5]
14	Write a program to design a real time clock based on RTC.	[3230.5]
15	Design a round robin scheduler can handle 4 task using embedded c.	[3230.5]

E. Course Articulation Matrix: (Mapping of COs with POs)

COs	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC3230.1]	Identify and describe various characteristics features and applications of embedded systems.	1		1	1									1	2	1
[EC3230.2]	Analyze and identify hardware for embedded system implementation		1	2	2	1						1	1	2	2	
[EC3230.3]	Analyze and identify various software issue involved in embedded system for real time requirement	1	1	2	1	1								2	1	
[EC3230.4]	Apply concepts of Real Time Operating Systems using Shell script/C/C++ and implement real time kernel objects using RTOS “uC-OS/II”(Analysis)	2	2	2	2	2		1				1	1	2	2	1
[EC3230.5]	Analyze and explain the design life cycle for embedded system implementation.	1	2			1	1		1			1	1	2	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR
School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Wireless Communication & Networks | EC 3240 | 3 Credits | 3 0 0 3

Session: Jan 24 –May 24 | Faculty: Dr. Tarun Kumar Dubey Class: Program Elective 1

A. **Introduction:** This course aims to introduce the modern wireless communication systems and their basic operational procedures. The course incorporates, basic understanding of the transmission fundamentals including its basic time domain & frequency domain concepts. The course gives the conceptual orientation about how wireless systems work, and what are the important parameters involved in modern wireless communication services.

B. **Course Outcomes:** At the end of the course, students will be able to:
[3240.1]. Identify the basic operational procedures related to the wireless systems.
[3240.2]. Describe the modern wireless communication systems and the signaling techniques.
[3240.3]. Classify appropriate techniques and software tools for testing important parameters involved in wireless communication.
[3240.4]. Compare the network concepts of modern communication systems for skill development.
[3240.5]. Apply logical methods for cellular systems to have employability in communication sector.
[3240.6]. Demonstrate knowledge of communication services to have better prospects of entrepreneurship.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PSO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PSO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PSO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PSO.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

[PSO.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

[PSO.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

[PSO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PSO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PSO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PSO.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

[PSO.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

[PSO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	20
	Sessional Exam II (Close Book)	20
	Two Assignments each of 05 marks Two Quizzes each of 05 marks	10 10
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments for Academic absence in the class.	Students who misses any assessment procedure will have to report to his/her faculty about the absence (with reason). Respective faculty as per the reason will, (with consent of the course coordinator) decide his/her eligibility for the reassessment. Date and time of the reassessment will be informed with prior notice.	
Homework/ Home Assignment/ Activity Assignment (Formative)	This is flipped class room activity. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed at the faculty level and might reflect in the internal marks.	

E. SYLLABUS

Introduction to wireless channels and wireless networks, wireless channel as a random linear time varying system, Wireless channel modeling, Advantages and disadvantages of Wireless Networks, WLAN Topologies, WLAN Standard IEEE 802.11 and IEEE 802.11 a, b, g and n standards. Outdoor Propagation Models- Longley Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model, Walfisch and Bertoni Model, Wideband PCS Microcell Model, Indoor Propagation Models-Partition losses (Same Floor), Partition losses between Floors, Log-distance path loss model, Ericsson Multiple Breakpoint Model. Fading and diversity techniques, Diversity improvement, Maximal Ratio Combining, Practical Space Diversity, Selection Diversity, Scanning Diversity, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver. Wireless channel capacity, ergodic capacity and outage capacity. Introduction to MIMO systems.

F. References:

Upena Dalal, Wireless Communication, (1e), Oxford University Press, 2009.
T. S. Rappaport, Wireless Communication: Principles and Practice, (2e), Pearson, 2010.
Andreas.F. Molisch, Wireless Communications, (2e), John Wiley – India, 2013.
William Stallings, Wireless Communications & Networks, (2e), Pearson, 2005.

Lec. No.	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1,2,3	Overview of wireless systems	Students would get acquainted with basic understanding of the wireless systems	PPT/ Board followed by activity	3240.1	Theory class
4,5,6	Wireless channel as a random linear time varying system	Knowledge of time varying systems.	PPT	3240.1	In Class Quiz Mid Term-01 End Term
7,8,9,10	Time domain & Frequency domain concepts	Students would be able to understand Time domain & Frequency domain concepts	Lecture	3240.1 &3240.2	In Home Assignment Mid Term-01 End Term
11,12,13	Wireless channel modelling	Understanding of Communication Networks/ modelling	Lecture	3240.2	In Class Quiz MidTerm-01 End Term
14,15,16	Cells, duplexing & multiplexing.	Basic Understanding of Cells, duplexing & multiplexing.	Lecture	3240.1 & 3240.3	MidTerm-02 End Term
17,18,19	Advantages and disadvantages of Wireless Networks	Basic Understanding of WLAN	Lecture & Self study	3240.1 & 3240.3	MidTerm-02 End Term
20,21	WLAN Standard IEEE 802.11 and IEEE 802.11 a, b, g and n standards	Students would get acquainted with basic understanding IEEE 802.11	PPT	3240.4	Tutorial 1
22,23,24	Outdoor Propagation Models- Longley	Knowledge of Propagation Models	PPT	3240.4 & 3240.5	In Class Quiz Mid Term-02 End Term
25,26,27	Okumura Model, Hata Model, PCS Extension to Hata Model, Walfisch and Bertoni Model	Knowledge of Propagation Models	Lecture	3240.4	In Class Quiz End Term
28,29,30	Wideband PCS Microcell Model, Indoor Propagation Models-Partition losses (Same Floor	Knowledge of Propagation Models	Lecture	3240.4	End Term
30,31,32	Diversity improvement, Maximal Ratio Combining, Practical Space Diversity	Aspect of Diversity	Lecture & Self study	3240.2 & 3240.5	End Term
33,34	Wireless channel capacity	Students would be able to understand the channel capacity in networks	PPT	3240.5 & 3240.6	Tutorial 2
35,36,37	RAKE Receiver	Knowledge of receiever fundamentals	PPT	3240.6	In Class Quiz
38,39,40	Introduction to MIMO systems	Basic Understanding of MIMO	Lecture	3240.4, 3240.5 & 3240. 6	End Term
41	Conclusion and Course Summarization	Knowledge of Wireless communication and Networks	Self study	3240.1 & 3240.6	End Term

G. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC3240.1	Identify the basic operational procedures related to the wireless systems	3	2	1	1									3	1	
EC3240.2	Describe the modern wireless communication systems and the signaling techniques	3	2	1	1									1	1	
EC3240.3	Classify appropriate techniques and software tools for testing important parameters involved in wireless communication	3	3	1	3	3								1	3	
EC3240.4	Compare the network concepts of modern communication systems for skill development	3	2	1	1									3		
EC3240.5	Apply logical methods for cellular systems to have employability in communication sector	3	3		2									1	1	3
EC3240.6	Demonstrate knowledge of communication services to have better prospects of entrepreneurship	3		3												

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Radar & Satellite Communication | EC 3241 | 3 Credits | 3 0 0 3

Session: January 24 – May 24 | Faculty: Madhuri Sahal | Program Elective

A. Introduction:

This course offers fundamental knowledge in radar and satellite communication & the principles and techniques used in radar & satellite communications. The course presents the types of radar, elements of radars, fundamental principles of radar communication & link budget analysis. The course also introduces to basics of satellite communication, satellite subsystem, their components & satellite applications.

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

[EC 3241.1] Evaluate key radar parameters and interpret their physical significance.

[EC 3241.2] Describe the functioning of radar receiver and interpret the effect of these parameters on detection for development of analytical skills

[EC 3241.3] Evaluate the link budget parameters using radar equation & explain the types of radar for employability enhancement.

[EC 3241.4] Apply the Kepler laws of motion to compute the key satellite/orbital parameters.

[EC 3241.5] Evaluate the link budget/link design parameters for a satellite communication link for enhancing employability.

[EC 3241.6] Explain the functioning of satellite subsystems & applications of satellites.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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.

[PO.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.

[PO.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.

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.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.

[PO.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.

[PO.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.

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	20
	Sessional Exam II (Close Book)	20
	In class Quizzes and Assignments, Activity feedbacks (Accumulated and Averaged)	20
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped	

	classroom participation by a student will be assessed and marks will be awarded.

E. SYLLABUS

EC3241 Radar & Satellite Communication [3 0 0 3]

Introduction to Radar: Introduction, block diagram, applications, radar frequencies, different types of radar, basic pulsed radar system, radar equation, system losses. **Radar Transmitter:** Introduction, radar RF source. **Radar Receiver:** Introduction, radar receiver noise, and **Duplexers:** Introduction types, used in modern radar, **Radar Display Units:** Introduction, types of scope. **Navigation:** Introduction, history, methods of navigation. **Satellite Communications:** The Origin of satellite communications, brief history of satellite communications, advantages and disadvantages, current status of satellite communication, active and passive satellites. **Satellite Subsystems:** Introduction, satellite subsystems, altitude and orbit control system, telemetry, tracking and command, communication subsystem, communication subsystem components. **Earth Station Technology:** Introduction, earth station design requirements, earth station antenna design, earth station sub-system, tracking monitoring and control. **Satellite link design:** Transmission equation, noise at the receiver, G/T ratio for earth stations, uplink equation. **Satellite Applications:** Introduction, satellite for earth observation, satellite for weather forecast, satellite for scientific studies, and satellite for military applications, direct broadcast satellite system, very small aperture terminal, global positioning system.

F. TEXT BOOKS

1. M. I. Skolnik, Introduction to Radar Systems, (3e), McGraw Hill, 2003.
2. T. Pratt, C. W. Bostian, J. E. Allnutt, Satellite communication system, (2e), John Wiley and Sons (2002).

G. REFERENCE BOOKS

1. P. Z. Peebles Jr., Radar Principles, (1e), John Wiley, 1998.
2. E. Byron, Radar: Principles, Technology, Applications, (1e), Prentice- Hall education, 1992.
3. D. Barton, Radar system analyses and Modelling, (2e), Artech house, 2005.
4. M. Antonio, Bistatic radar emerging technology, (1e), John Wiley, 2008.
5. D. Roddy, Satellite communications, (4e), McGraw-Hill international edition, 2017.

Lecture Plan:

Lecture No.	Topic	Session outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1.	Introduction to course	Familiarize with Course handout discussion	flipped classroom	EC3241.1	Assignment
2.	Introduction to Radar: Introduction, radar frequencies, different types of radar,	Able to understand Radar fundamentals	lecture	EC3241.1	Assignment/Quiz/Mid-term-1
3.	Terminology/definitions, applications,	Able to understand Radar Terminology	lecture	EC3241.1,3	Assignment/Quiz/Mid-term-1
4.	Types of radar-monostatic, bistatic, quasi-monostatic, CW and pulsed radar	Explain the Types of radar	lecture	EC3241.1,3	Assignment/Quiz/Mid-term-1/ETE
5.	FM-CW radar block diagram,	Explain the FMCW radar	lecture	EC3241.1,3	Assignment/Quiz/Mid-term-1/ETE
6.	FM-CW radar principle and operation,	Understand working of FMCW radar	lecture	EC3241.1,3	Assignment/Quiz/Mid-term-1/ETE
7.	basic pulsed radar system-block diagram	Explain the pulsed radar	lecture	EC3241.1,3	Assignment/Quiz/Mid-term-1/ETE
8.	MTI radar-doppler effect principle and block diagram	Explain the principle of MTI radar	lecture	EC3241.1,3	Assignment/Quiz/Mid-term-1/ETE
9.	MTI radar- block diagram	Explain working & operation of MTI radar	lecture	EC3241.1,3	Assignment/Quiz/Mid-term-1/ETE
10.	Numerical problems	Examples of computation of radar parameters	lecture	EC3241.3	Assignment/Quiz/Mid-term-1/ETE
11.	Radar equation, system losses.	Able to calculate min & max range	lecture	EC3241.3	Assignment/Quiz/Mid-term-1/ETE
12.	Radar equation in terms of S/N	Use radar equation to compute various parameters	lecture	EC3241.3	Assignment/Quiz/Mid-term-1/ETE
13.	Numerical problems	Examples of computation of radar parameters	lecture	EC3241.3	Assignment/Quiz/Mid-term-1/ETE
14.	Link budget analysis	Link budget calculations	lecture	EC3241.3	Assignment/Quiz/Mid-term-1/ETE
15.	Numerical problems	Examples of computation of Link budget parameters	lecture	EC3241.3	Assignment/Quiz/Mid-term-1/ETE
16.	Radomes.	Introduction about radomes	lecture	EC3241.2	Assignment/Quiz/Mid-term-1/ETE
17.	Radar Transmitter: Introduction, radar RF source.	Explain block diagram of radar transmitter	lecture	EC3241.2	Assignment/Quiz/Mid-term-1/ETE
18.	Radar Transmitter: Introduction, radar RF source.	Explain operation of radar transmitter	lecture	EC3241.2	Assignment/Quiz/Mid-term-1/ETE
19.	Radar Receiver: Introduction, radar receiver	Explain concept of radar receiver, heterodyning	lecture	EC3241.2	Assignment/Quiz/Mid-term-1/ETE
20.	Radar Receiver: Introduction, radar receiver noise,	Explain working of radar receiver	lecture	EC3241.2	Assignment/Quiz/Mid-term-1/ETE

21.	Probability of false alarm	Compute probability of false alarm	lecture	EC3241.2	Assignment/Quiz/Mid-term-1/ETE
22.	Numerical problems	Numericals on calculation of prob of false alarm	lecture	EC3241.2,3	Assignment/Quiz/Mid-term-1/ETE
23.	Duplexers: Introduction types, used in modern radar,	Explain purpose and xtypes of duplexers	lecture	EC3241.2,3	Assignment/Quiz/Mid-term-1
24.	Radar Display Units: Introduction, types of scope.	Introduction to radar display units -types	lecture	EC3241.2,3	Assignment/Quiz/Mid-term-1
25.	Navigation: Introduction, history, methods of navigation.	Introduction about navigation	lecture	EC3241.4	Assignment/Quiz/Mid-term-1
26.	Satellite Communications: The Origin of satellite communications, brief history of satellite communications,	Familiarize with fundamentals of satellite communication	flipped classroom	EC3241.4	Assignment/Quiz/ETE
27.	advantages and disadvantages, current status of satellite communication, active and passive satellites, Kepler's laws	Types of satelllites and Kepler's laws	lecture	EC3241.4	Assignment/Quiz/ETE
28.	Satellite Subsystems: Introduction, satellite subsystems, principle-Kepler's laws	Introduction about satellite subsystems	lecture	EC3241.6	Assignment/Quiz/ETE
29.	altitude and orbit control system,	Explain AOCS	lecture	EC3241.6	Assignment/Quiz/ETE
30.	telemetry, tracking and command,	Explain TTC	lecture	EC3241.6	Assignment/Quiz/ETE
31.	communication subsystem, communication subsystem components.	Apply heterodyning concept to compute various frequencies	lecture	EC3241.6	Assignment/Quiz/ETE
32.	Satellite transponder, types and working	Explain communication subsystem and its components	lecture	EC3241.5,6	Assignment/Quiz/ETE
33.	Earth Station Technology: Introduction, earth station design requirements,	Explain the working of satellite transponder	lecture	EC3241.5,6	Assignment/Quiz/ETE
34.	earth station antenna design, earth station sub-system,	Design requirements of an earth station	lecture	EC3241.5,6	Assignment/Quiz/ETE
35.	earth station sub-system,	Explain an Earth station subsytem	lecture	EC3241.5,6	Assignment/Quiz/ETE
36.	tracking monitoring and control.	Explain tracking & control	lecture	EC3241.5,6	Assignment/Quiz/ETE
37.	Satellite link design:Transmission	Derive transmission equation,solve	lecture	EC3241.5	Assignment/Quiz/ETE

	equation,noise at the receiver,	link design problems			
38.	G/T ratio for earth stations, uplink equation.	Derive uplink equation	lecture	EC3241.5	Assignment/Quiz/ ETE
39.	Link budget analysis	Able to compute parameters relating to link budget analysis	lecture	EC3241.5,6	Assignment/Quiz/ETE
40.	Numericals	Examples on link budget analysis	lecture	EC3241.6	Assignment/Quiz/ETE
41.	Satellite Applications: Introduction, satellite for earth observation, satellite for weather forecast, satellite for scientific studies,	Explain satellite applications	flipped classroom /activity	EC3241.6	Assignment/Quiz/ETE
42.	satellite for military applications, direct broadcast satellite system, very small aperture terminal, global positioning system.	Explain satellite applications	flipped classroom /activity	EC3241.6	Assignment/Quiz/ETE
43.	Doubts/Revision				Assignment/Quiz/ETE

Madhuri Madhuri Sahal

A. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC 3241.1]	Evaluate key radar parameters and interpret their physical significance.	2	2	1	0	0	0	0	0	0	0	0	1	2	2	0
[EC 3241.2]	Describe the functioning of radar receiver and interpret the effect of these parameters on detection for development of analytical skills	2	2	2	1	0	0	0	0	0	1	0	0	2	2	0
[EC 3241.3]	Evaluate the link budget parameters using radar equation for employability enhancement & explain the types of radar.	2	2	2	1	0	1	0	0	0	1	1	1	2	2	0
[EC 3241.4]	Apply the Kepler laws of motion to compute the key satellite/orbital parameters.	2	1	0	0	0	0	0	0	0	0	0	0	1	1	0
[EC 3241.5]	Evaluate the link budget/link design parameters for a satellite communication link for enhancing employability.	2	2	2	1	0	1	0	0	0	0	1	0	2	2	0
[EC 3241.6]	Explain the functioning of satellite subsystems & applications of satellites.	1	1	0	0	0	0	0	0	0	1	1	1	2	0	0
		2	2	2	1	0	0	0	0	0	1	1	1	2	2	0

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Madhuri Madhuri Sahal

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

VLSI TESTING & TESTABILITY EC3242 | 3 Credits | 3 0 0 3

Session: Jan 24– May 24 | Faculty: Dr. Neha Singh | Class: Program Elective Course

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a program elective Course. The course is mandatory for minor specialization in VLSI with an objective to prepare them for jobs as verification engineers in the industry. It targets the students interested in the domain of VLSI design to introduce them to the field of Design for Testability. The course covers techniques for efficient testing and the technique of automated test pattern generation and fault detection for digital circuits and memory. Students are expected to have background knowledge of Digital Electronics for better understanding of the course.

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

[EC3242.1] Understand the concepts of VLSI testing and design for testability for Built-in Self-Test.

[EC3242.2] Apply the concepts fault modelling and collapsing for optimal fault coverage in digital circuits and memories.

[EC3242.3] Analyze various fault simulation and detection methods for digital circuits and memories.

[EC3242.4] Apply various test pattern generation methods for fault testing in digital circuits, memories.

[EC3242.5] Evaluate controllability and observability of digital circuits.

[EC3242.6] Evaluate different methods for test response compaction.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.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

[PO.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

[PO.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

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Mid term Exam (Close Book)	30
	In class Quizzes and Research assignments	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given. These assignments are limited to a maximum of 5 throughout the entire semester.	
Activity Assignment & Quiz (Summative)	Minimum 3 Quiz will be given.	

E. SYLLABUS

Introduction: Verification vs Testing, Need for testing, Level of testing, Cost of testing, Roles of testing. Types of testing: Manufacturing test, Burn-in and stress test, Functional test. Automatic test equipment (ATE). Electrical parameter testing. **Test Economics:** Basics of cost analysis, Benefit-cost analysis, Economics of design-for-testability (DFT), VLSI chip yield, Defect level. **Fault modelling:** Stuck at Faults, Bridging Faults; Fault collapsing; Transistor (switch) faults. **Fault Simulation:** Deductive, Parallel and Concurrent Fault Simulation. Critical Path Tracing. **ATPG for Combinational Circuits**: D-Algorithm, PODEM, Random pattern generation, Boolean difference symbolic method, Path sensitization method, Computation complexity. **Compaction Techniques:** General Aspects of Compaction Techniques; Ones-Count, Transition Count and Parity Check Compression; Syndrome Testing; Signature Analysis. **SCOAP Controllability and Observability measure**. **Sequential Circuit ATPG:** Time frame expansion, Nine-valued logic, Drivability, Complexity of ATPG, Test generation system. **Functional Testing:** Structure independent and structure dependent approach. Delay Test: Path delay fault testing, transition fault testing, pattern generation, Scan-based delay fault test. **Scan design:** Scan flip-flop, Muxed-DFF, LSSD, Scan test vectors, Multiple scan registers, Hierarchical scan. Partial scan architecture, Scan flip-flop selection methods, Cyclic and acyclic structures, Scan-hold flip-flops. **IDDQ Current Testing:** Basic principle of IDDQ testing, Fault detected by IDDQ tests, Limitations of IDDQ testing. **Memory Testing:** Fault models, March tests. **Built-In Self-Test (BIST) concept**: BIST pattern generation, BIST response compaction, Aliasing definition. BIST Architecture**.**

F. REFERENCE BOOKS

1. M. Bushnell and V. Agrawal, Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits, Kluwer Academic Publishers, 2000.
2. M. Abramovichi, M. Breuer and A. Friedman, Digital Systems Testing and Testable Design, IEEE Press, 1999.
3. L. T. Wang, C. W. Wu and X. Wen, VLSI Test Principles and Architectures, Elsevier, 2006

G. Lecture Plan:

Lect No.	Topics to be Covered.	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1.	Overview of the Course	To acquaint and clear teacher's expectations and understand student expectations	Lecture	NA	NA
2	**Introduction:** Verification vs Testing, Need for testing, Level of testing, Cost of testing, Roles of testing. Types of testing: Manufacturing test, Burn-in and stress test, Functional test. Automatic test equipment (ATE). Electrical parameter testing.	To understand need and types of testing	Lecture	EC3242.1	Class test MTE ETE
3-4	Fault Modelling: Stuck at Faults, Bridging Faults; Transistor (switch) faults	Understand faults	Lecture	EC3242.2	Class test MTE ETE
5-6	Fault equivalence, dominance and collapsing;	To reduce the number of s-a-faults to be tested	Lecture	EC3242.2	Class test MTE ETE
7	Fault Simulation: Series, and Parallel Fault Simulation.	To simulate the fault tests	Lecture	EC3242.3	Class test MTE ETE
8	Deductive fault simulation	To simulate the fault tests	Lecture	EC3242.3	Class test MTE ETE
9-10	Concurrent fault simulation	To simulate the fault tests	Lecture Tutorial	EC3242.3	Class test MTE ETE

11	Critical Path Tracing Tutorial1: Fault collapsing + Bridging Faults	To detect faults using critical path tracing	Lecture Tutorial	EC3242.2 EC3242.3	Class test MTE
12	ATPG for Combinational Circuits: D-Algorithm	To understand basics of ATPG algorithms, primitive cubes and singular cover	Lecture	EC3242.4	Class test MTE ETE
13	ATPG for Combinational Circuits: D-Algorithm	To apply D-Algorithm for test pattern generation	Tutorial	EC3242.4	Class test MTE ETE
14	PODEM, Random pattern generation, Boolean difference symbolic method, Path sensitization method, Computation complexity.	To understand random pattern generation method, Boolean difference and path sensitization methods of test pattern generation	Lecture	EC3242.4	Class test MTE
15-16	**Sequential Circuit ATPG:** Time frame expansion, Nine-valued logic, Drivability, Complexity of ATPG, Test generation system.	To apply test pattern generation algorithm to sequential circuits	Lecture	EC3242.4	Class test MTE
17-18	Observability and Controllability (Testability measures)	To assess controllability and observability of each line in combinational circuits *and sequential circuits*	Lecture	EC3242.5	Class test MTE ETE
19-20	**Scan design:** Scan flip-flop, Muxed-DFF, LSSD, Scan test vectors, Multiple scan registers, Hierarchical scan. Partial scan architecture, Scan flip-flop selection methods, Cyclic and acyclic structures, Scan-hold flip-flops.	To assess the need of Scan chain design	Lecture	EC3242.1	Class test MTE ETE
21-22	Memory Testing: Permanent, Intermittent and Pattern Sensitive Faults	Understand different memory faults and state transition diagram to represent faults	Lecture	EC3242.2 EC3242.3	Class test MTE ETE
23-24	March Tests	Understand March Test and apply it for testing various faults	Lecture	EC3242.3	Class test MTE ETE
25-26	**Compaction Techniques:** General Aspects of Compaction Techniques; Ones-Count, Transition Count and Parity Check Compression;	Understand the need for response compaction and implement different compression methods	Lecture	EC3242.6	Class test MTE ETE
27-29	Syndrome Testing; Signature Analysis	Use LFSR for random sequence generation and signature analysis	Lecture	EC3242.6	Class test MTE ETE
30	**Functional Testing:** Structure independent and structure dependent approach. Delay Test: Path delay fault testing, transition fault testing, pattern generation, Scan-based delay fault test.	Represent faults in PLA, generate test for PLA testing	Lecture	EC3242.1 EC3242.2	Class test ETE
31-32	**Built-In Self-Test (BIST) concept**: BIST pattern generation, BIST response compaction, Aliasing definition. BIST Architecture**.**	Understand the need for Built-in self test and its implementation	Lecture	EC3242.1	Class test ETE
33-34	**IDDQ Current Testing:** Basic principle of IDDQ testing, Fault detected by IDDQ tests, Limitations of IDDQ testing.	Numerical practice for memory testing, PLA testing, compaction methods, BISR	Tutorial	EC3242.1 EC3242.3	Class test ETE
35-36	**Test Economics:** Basics of cost analysis, Benefit-cost analysis, Economics of design-for-testability (DFT), VLSI chip yield, Defect level.	Understand test economics	Lecture	EC3242.1	Class test ETE

H. Course Articulation Matrix: (Mapping of COs with POs)

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC3242.1]	Apply the concepts of testing by modelling different faults for fault free simulation in digital circuits	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
[EC3242.2]	Apply various test generation methods for fault detection in digital circuits	0	2	0	1	0	0	0	0	0	0	0	0	0	1	0
[EC3242.3]	Apply various test methods for fault testing in memories and PLA	0	2	0	1	0	0	0	0	0	0	0	0	1	1	0
[EC3242.4]	Apply different methods for test response compaction for fault detection	0	2	0	0	0	0	0	0	0	0	0	0	1	1	0
[EC3242.5]	Understand Built-in Self-Test methods for improving testability of digital circuits	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0

Dr Neha Singh

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

VLSI Design with Verilog HDL| EC 3251 | 3 Credits | 3 0 0 3

Session: Jan 24 – May 24 | Faculty: Dr. Shilpi Birla| Class: Dep. Elective (VI Sem)

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a department elective, targeting students who wish to pursue research & development in industries or higher studies in field of Electronics Engineering especially VLSI Design. The objective of the course is to provide a thorough understanding about designing of digital circuits & Test bench-based verification using Verilog HDL. The Digital Electronics is the pre-requisite for this course.

B. Course Objectives: At the end of the course, students will be able to

[3251.1] Describe the basic attributes, operators & syntax of Verilog HDL for implementation of digital circuits using Verilog for enhanced employability.
[3251.2] Discuss the structural, register-transfer level (RTL), and algorithmic levels of abstraction for modelling digital hardware systems.
[3251.3] Explain modelling of combinational and sequential digital systems (Finite State Machines) for acquiring skills in the domain of Digital Systems.
[3251.4] Apply the concept of test-benches to create testing behavioural environments for simulation-based verification.
[3251.5] Illustrate problems of finite state machine for various system implementation.
[3251.6] Analyse circuits efficiently in digital system design to achieve optimization for high device utilization and performance for digital applications.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.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

[PO.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

[PO.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

[PO.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

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the

engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.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

[PO.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

[PO.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

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	MTE (Closed Book)	30
	CWS components	30
End Term Exam (Summative)	ETE (Closed Book)	40
	Total	**100**
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be eligible to appear for the ETE. The allowance of 25% includes all types of leaves including medical leaves.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Some of these works are graded with marks. A student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. Syllabus

Introduction to Verilog HDL, Hardware Simulation & Synthesis, Verilog Attributes: Switch level, Gate level. Pin to Pin Delay, Dataflow, Top-Down design with Verilog, Subprograms, Operators, Syntax and constraints. Characterization of HDL: Timing, concurrency, data types, nets, Verilog primitives. Modeling oof Test Bench. Combinational and Sequential Design. Usage of subprograms, parametrization and specifications, path delay specification. Utilities for high level Description. Dataflow description, Behavioural Description of Hardware, Modelling for Hardware Design. Interface design & Modeling.

F. Reference Books:

1. Kenneth S Kundert, Olaf Zinke, Designers Guide to Verilog AMS, Springer, 2004
2. Samir palnitkar, Verilog HDL, Pearson education, Second Edition, 2003.
3. J. Bhasker, A Verilog HDL Primer, Second Edition, Star Galaxy, 2005.

G. Lecture Plan:

Lecture No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction to Verilog HDL.	Need of the course	Lecture & PPT	NA	NA
2	Hardware Simulation & Synthesis.	Understand the difference between simulation & synthesis	Lecture & PPT	3251.1	In Class Quiz Mid Term I End Term
3	Hardware Simulation & Synthesis.	Understand the difference between simulation & synthesis	Lecture & PPT	3251.1	In Class Quiz Mid Term I End Term
4	Verilog Attributes: Syntax	Attributes & Syntax	Lecture & PPT	3251.1	In Class Quiz Mid Term I End Term
5	Operators & constraints	To understand the operators & constraints	Lecture & PPT	3251.1	Class Quiz Mid Term I End Term
6	Operators & constraints	To understand the operators & constraints	Lecture & PPT	3251.1	Class Quiz Mid Term I End Term
7	Gate level Designing	Understand & implementation of the Gate level	Lecture & PPT	3251.2	Home Assignment Mid Term I End Term
8	Gate level Designing	Understand & implementation of the Gate level	Lecture & PPT	3251.2	Home Assignment Mid Term I End Term
9	Switch level Designing	Understand & implementation of the Switch level	Lecture & PPT	3251.2	Class Quiz Mid Term I End Term
10	Switch level Designing	Understand & implementation of the Switch level	Lecture & PPT	3251.2	Class Quiz Mid Term I End Term
11	Verilog primitives.	Understand the verilog primitive and their uses	Lecture & PPT	3251.2	Class Quiz Mid Term I End Term
12	Implement Combinational Design using Various styles (Baisc circuits: adders, MUX, DMUX)	Implementation of combinational circuits	Lecture & PPT	3251.3 3251.4	Home Assignment Mid Term 1 End Term
13	Implement Combinational Design using Various styles (Decoders, encoders, higher order designs)	Implementation of combinational circuits	Lecture & PPT	3251.3 3251.4	Home Assignment Mid Term 1 End Term
14	Implement Combinational Design using Various styles (code converters and designing problems)	Implementation of combinational circuits	Lecture & PPT	3251.3 3251.4	Home Assignment Mid Term 1 End Term
15	Writing of Test Bench.	understand the Test benches and its application	Lecture & PPT	3251.4	Home Assignment Class Quiz

					Mid Term 1 End term
16	Implement Sequential Design.(Latches and flipflops)	Implementation of sequential circuits	Lecture & PPT	3251.3 3251.4	Home Assignment Mid Term 1 End Term
17	Implement Sequential Design. (Registers)	Implementation of sequential circuits	Lecture & PPT	3251.3 3251.4	Home Assignment Mid Term 1 End Term
18	Implement Sequential Design. (Counters)	Implementation of sequential circuits	Lecture & PPT	3251.3 3251.4	Home Assignment Mid Term 1 End Term
19	Usage of subprograms, parametrization, and specifications,	Understand to write Verilog code efficiently using other methods	Lecture & PPT	3251.3 3251.4	Class Quiz Mid Term 1 End Term
20	Writing of Test Bench.	understand the Test benches and its application	Lecture & PPT	3251.4	Home Assignment Class Quiz Mid Term 1 End term
21	Timing Constraints (introduction)	Understand to calculate and consider timing delays in circuits.	Lecture & PPT	3251.3 3251.4	Class Quiz Mid Term 1 End Term
22	Timing Constraints (Various types)	Understand to calculate and consider timing delays in circuits.	Lecture & PPT	3251.3 3251.4	Class Quiz Mid Term 1 End Term
23	Timing Constraints (Violations)	Understand to calculate and consider timing delays in circuits.	Lecture & PPT	3251.3 3251.4	Class Quiz Mid Term 1 End Term
24	Design problems		Discussion	3251.3 3251.4	Class Quiz Mid Term II End Term
25	Introduction to FSM, Designing of FSMs (Moore)	Designing of FSMs different examples	Lecture & PPT	3251.5	Class Quiz Mid Term I End Term
27	Introduction to FSM, Designing of FSMs(Mealy)	Designing of FSMs different examples	Lecture & PPT	3251.5	Class Quiz Mid Term I End Term
28	Implementation of FSMs using Verilog HDL: Moore	Implementation of FSMs in Verilog	Discussion	3251.4 3251.5	Class Quiz Mid Term I End Term
29	Implementation of FSMs using Verilog HDL: Mealy	Implementation of FSMs in Verilog	Discussion	3251.4 3251.5	Class Quiz Mid Term I End Term
30	Design problems		Discussion	3251.4 3251.5	Class Quiz Mid Term II End Term
31	Testbenches for FSMs	How to write Test benches for FSMs	Lecture & PPT	3251.4 3251.5	Class Quiz Mid Term I End Term

32	Modelling for Hardware Design.	Analyse circuit design and model and synthesis	Lecture & PPT	3251.6	Class Quiz Mid Term I End Term
33	Interface design & Modelling.	Analyse circuit design and model and synthesis	Lecture & PPT	3251.6	Class Quiz Mid Term II End Term
34	Interface design & Modelling.	Analyse circuit design and model and synthesis	Lecture & PPT	3251.6	Class Quiz Mid Term II End Term
35-36	Design problems		Discussion	3251.6	Class Quiz Mid Term II End Term

H. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 3251.1	Describe the basic attributes, operators & syntax of Verilog HDL for implementation of digital circuits using Verilog for enhanced employability.	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
EC 3251.2	Discuss the structural, register-transfer level (RTL), and algorithmic levels of abstraction for modelling digital hardware systems.	2	0	0	0	0	0	0	0	0	0	0	0	1		0
EC 3251.3	Explain modelling of combinational and sequential digital systems (Finite State Machines) for acquiring skills in the domain of Digital Systems.	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0
EC 3251.4	Apply the concept of test-benches to create testing behavioural environments for simulation-based verification.	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0
EC 3251.5	Illustrate problems of finite state machine for various system implementation.	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0
EC 3251.6	Analyse circuits efficiently in digital system design to achieve optimization for high device utilization and performance for digital applications.	2	2	1	1	1	0	0	1	0	0	0	0	2	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation