Course Code: ECE2004	**Course Title:** Network Theory **Type of Course:** Program Core& Theory only	**L-P-C**	**3**	**0**	**3**
Version No.	2.0				
Course Pre-requisites	**Fundamental concepts of Electrical Components and Laws like Ohm's and Kirchhoff's laws. Basic knowledge of differential & integral calculus and Linear algebra. Methods of solving Differential equations.**				
Anti-requisites	**NIL**				
Course Description	This Course aims at obtaining the solutions to problems in electrical networks, using network reduction techniques and source transformations. The course also focuses on identifying and solving problems in electric circuits by applying network theorems. **The course is conceptual and is an introductory level course and introduces students to the concepts of** two port networks, behaviour under transient conditions.				
Course objective	The objective of the course is to familiarize the learners with the concepts of Network Theory and attain **SKILL DEVELOPMENT** through **PROBLEM SOLVING .**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. **Discuss** various network reduction techniques. 2. **Verify** various network theorems. 3. **Summarize** the behavior of RL, RC circuits 4. **Demonstrate** Series and Parallel Combination of Passive Components as resonating circuits, related parameters and analyze frequency response 5. **Illustrate the operation of** two-port networks.				
Course Content:					
Module 1	**Network Reduction Techniques and Source transformation**	Assignment/Quiz	Problem Solving task	**13 Sessions**	
Topics: Types of electric circuit elements and sources, Source transformation, Mesh analysis, Super mesh analysis, Nodal analysis, Super node analysis, Star and delta transform, Loop and node analysis with linearly dependent and independent sources for DC and AC networks					
Module 2	**Network Theorems**	Assignment/Quiz	Simulation task	**10 Sessions**	
Topics: Network Theorems, Explanation of Superposition, Thevenin's, Norton and Maximum power transfer theorems and numerical examples on the same.					
Module 3	**Transient analysis**	Assignment	Simulation task	**10Sessions**	
Topics: Initial conditions, transient analysis of RL, RC circuits in time and frequency domains using Laplace					

transforms

Resonance: Series and parallel resonance, frequency- response of series and Parallel circuits, Q–Factor, Bandwidth, Circuit Magnification Factor

Module 4	**Two-portnetworks** Assignment	Problem Solving task	**9 Sessions**

Topics:

Introduction to Two-port networks, Z-Parameter, Y-Parameter, ABCD Parameter, H-Parameter and Transmission parameters,modelling with these parameters, relationship between parameters sets.

Text Book(s):

1. Ravish.R.Singh, "Electrical Networks", Mcgraw Hill company,2009
2. J.A.Edminister, "Theory and Problems of Electric Circuits", Schaum's Outline Series, 4th Edition.

References:

3. G.K.Mittal, "Network Analysis,Khanna", Publishers,8th edition.
4. Van Valkenberg, "Network Analysis", Prentice Hall, 1974. PHI.

Online and Web Resource (s):

1.NPTEL video lecture by Prof. Tapas Kumar Bhattacharya, Department of Electrical Engineering, IIT Kharagpur:https://archive.nptel.ac.in/courses/108/105/108105159/

2. NPTEL video lecture by Prof A. Mukharjeehttps://nptel.ac.in/courses/106105154

3. NPTEL assignments: https://archive.nptel.ac.in/courses/108/105/108105159/

4. Presidency Library Link:-https://presiuniv.knimbus.com/user#/home

E-Content:

1. FerranReverter, ManelGasulla, "A Novel General-Purpose Theorem for the Analysis of Linear Circuits", IEEE Transactions on Circuits and Systems II: Express Briefs, vol.68, no.1, pp.63-66, 2021. https://ieeexplore.ieee.org/document/9112277

2. Kirchhoff's laws and Tellegen's theorem for networks and continuous media, IEEE Transactions on Circuits and Systems (Volume: 31, Issue: 7, July 1984) https://ieeexplore.ieee.org/document/1085549

3. G. Litjens, T. Kooi, B. Ehteshami, Bejnordi, A. A. A. Setio, F. Ciompi, et al., "A survey on deep learning in medical image analysis", *Medical Image Analysis*, vol. 42, pp. 60-88, 2017.https://pubmed.ncbi.nlm.nih.gov/28778026/

4. A New Method for Generating a Function of Two Independent Variables, IRE Transactions on Electronic Computers (Volume: EC-6, Issue: 3, September 1957) https://ieeexplore.ieee.org/abstract/document/5222014

Topics relevant to "SKILL DEVELOPMENT": Network Theorems, Transient Analysis and Two-port networks **for Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.**

Catalogue prepared by	Mrs. Aruna M
Recommended by the Board of Studies on	**BOS Meeting NO: 15th, Dated BOS 28/07/2022**
Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-8[2021] COURSE HAND OUT

SCHOOL: Engineering **DEPT.:** Electronics and Communication Engineering **DATE OF ISSUE:** 23/08/2021

NAME OFPROGRAM:B.Tech

P.R.C. APPROVALREF : 1PU/AC-16/ECE/2020-2024/2021

SEMESTER/YEAR : 3/2stYear

COURSE TITLE&CODE : Network Theory& ECE2004

COURSECREDITSTRUCTURE: **3 Credits (L=3, T=0, P=0, C=3)**

CONTACTHOURS : 3 Hours/Week

COURSE INSTRUCTOR : Dr. Balaji

PROGRAM OUTCOMES:

Graduates of the B. Tech. Program in Electronics and Communication Engineering will be able to:

PO1. Engineering knowledge: **Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.**

PO2. Problem analysis: **Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.**

PO3.Design/development of solutions: **Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.**

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO5. **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.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: **Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions**.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:

Fundamental concepts of Electrical Components and Laws like Ohm's and Kirchhoff's laws. Basic knowledge of differential & integral calculus and Linear algebra. Methods of solving Differential equations.

COURSE DESCRIPTION:

This Course aims at obtaining the solutions to problems in electrical networks, using network reduction techniques and source transformations. The course also focuses on identifying and solving problems in electric circuits by applying network theorems. The course is conceptual and is an introductory level course and introduces students to the concepts of two port networks, behavior under transient conditions.

Course Objective:

The objective of the course is to familiarize the learners with the concepts of Network Theory and attain **SKILL DEVELOPMENT** through **PROBLEM SOLVING.**

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

1. Discuss various network reduction techniques.
2. Verify various network theorems.
3. Summarize the behavior of RL, RC circuits
4. Demonstrate Series and Parallel Combination of Passive Components as resonating circuits, related parameters and analyze frequency response
5. Illustrate the operation of two-port networks.

MAPPING OF C.O. WITH P.O

C.O.N0.	P.O.01	P.O.02	P.O.03	P.O.10
1	H	H		L
2	H			L
3	H	H	M	L
4	H	H		L
5	H	H	M	L

COURSE CONTENT (SYLLABUS):

Module 1:Network Reduction Techniques and Source transformation [13Hrs.][Bloom's levelselected:Comprehension]

Types of electric circuit elements and sources, Source transformation, Mesh analysis, Super mesh analysis, Nodal analysis, Super node analysis, Star and delta transform, Loop and node analysis with linearly dependent and independent sources for DC and AC networks

Module 2: Network Theorems [10 Hrs.][Bloom's levelselected:Comprehension]

Network Theorems, Explanation of Superposition, Thevenin's, Norton and Maximum power transfer theorems and numerical examples on the same.

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Module 3: Transient analysis **[10 Hrs.]Bloom's level selected: Comprehension]**

Initial conditions, transient analysis of RL, RC circuits in time and frequency domains using Laplace transforms. Resonance: Series and parallel resonance, frequency- response of series and Parallel circuits, Q–Factor, Bandwidth, Circuit Magnification Factor

Module 4:Two-portnetworks **[09 Hrs.]Bloom's level selected: Comprehension]**

Introduction to Two-port networks, Z-Parameter, Y-Parameter, ABCD Parameter, H-Parameter and Transmission parameters, modelling with these parameters, relationship between parameters sets.

SKILL SETS TO BE DEVLOPED:

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. **Ability to interpret events and results.**
4. **Ability to work as a leader and as a member of a team.**
5. **Assess errors in systems/processes/programs/computations and eliminate them.**
6. **Observe and measure physical phenomena.**
7. **Write reports.**
8. **Select suitable equipment, instrument, materials & software**
9. **Locate faults in system/Processes/software.**
10. **Manipulative skills for setting and handling systems/Process/Issues**
11. **The ability to follow standard /legal procedures.**
12. **An awareness of the Professional Ethics.**
13. **Need to observe safety/General precautions.**
14. **To judge magnitudes/Results/issues without actual measurement/actual contacts**

DELIVERY PROCEDURE (PEDAGOGY):

Lectures will be conducted with the aid of multi-media projector, blackboard, etc. Assignments based on coursecontentswillbegiventothestudentsattheendofeachunit/topicandwillbeevaluatedatregular interval

Self-Learning Topics:

a) Explanation of Norton's theorem and Reciprocity theorem
b) Construction of Dual networks
c) Basics of Laplace transform.

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REFERENCE MATERIALS:

(I) Text Book(s):

1. Ravish.R.Singh, “Electrical Networks”, Mcgraw Hill company,2009
2. J.A.Edminister, “Theory and Problems of Electric Circuits”, Schaum’s Outline Series, 4th Edition.

(II). Reference Book(S)

1. G.K.Mittal, “Network Analysis,Khanna”, Publishers,8th edition.
2 . Van Valkenberg, “Network Analysis”, Prentice Hall, 1974. PHI.

(III) Class Notes / Online Resources

1. NPTEL video lecture by Prof. Tapas Kumar Bhattacharya, Department of Electrical Engineering, IIT Kharagpur: https://archive.nptel.ac.in/courses/108/105/108105159/

2. NPTEL video lecture by Prof A. Mukharjeehttps://nptel.ac.in/courses/106105154

3. NPTEL assignments: https://archive.nptel.ac.in/courses/108/105/108105159/

(IV) E-content

1. FerranReverter, ManelGasulla, "A Novel General-Purpose Theorem for the Analysis of Linear Circuits", IEEE Transactions on Circuits and Systems II: Express Briefs, vol.68, no.1, pp.63-66, 2021. https://ieeexplore.ieee.org/document/9112277

2. Kirchhoff's laws and Tellegen's theorem for networks and continuous media, IEEE Transactions on Circuits and Systems (Volume: 31, Issue: 7, July 1984) https://ieeexplore.ieee.org/document/1085549

3. G. Litjens, T. Kooi, B. Ehteshami, Bejnordi, A. A. A. Setio, F. Ciompi, et al., "A survey on deep learning in medical image analysis", *Medical Image Analysis*, vol. 42, pp. 60-88, 2017.https://pubmed.ncbi.nlm.nih.gov/28778026/

4. A New Method for Generating a Function of Two Independent Variables, IRE Transactions on Electronic Computers (Volume: EC-6, Issue: 3, September 1957)

https://ieeexplore.ieee.org/abstract/document/5222014

(V)GUIDELINES TOSTUDENTS:

1. Students are required to maintain classwork which will be evaluate at the end of every month

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2. Students are required to strictly adhere to assignment deadlines.
3. Students are required to actively participate in classroom discussions and other activities which is planned in the classroom.
4. Students are required to have minimum of 75% of attendance to be eligible to attend exam.
5. Follow NPTELvideos

(VI) Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Introduction to Network Theory and its importance in Program			2
02	Introduction of course Network Theory			1
03	Module : 01			10
04	Module : 02			7
05	Mid- Term			
06	Discussion on Mid-Term			1
07	Module : 02 contd			3
08	Module:03			10
11	Module:04			9
12	Concluding the course and discussion on END term exam			1

SCHEDULE OF INSTRUCTION:

Sl. no	Session no.	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1	L1	Program Integration	Introduction to Network Theory and its importance in Program		Lecture	

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2	**L2**	Course Integration	Introduction of course Network Theory		**Lecture**	**T1:Ch1,** **R2:Ch1**
3	**L3**	Types of electric circuit elements and sources	Introduction, Resistance, Inductance, Capacitance and Sources	**CO 1**	**Lecture**	**T1: Ch.1.1, 1.2, 1.3, 1.4, 1.5** **R2:1.4, 1.5, 1.6**
4	**L4**	Source transformation	Sourse transformation, Examples	**CO 1**	**Lecture**	**T1:Ch 1.8** **R2:Ch 3.3**
5	**L5**	Source Shifting	Source Shifting, Examples	**CO1**	**Lecture**	**T1:Ch 1.9**
6	**L6**	Star-Delta transformation	Star-Delta transformation, Delta to Star Transformation, Star to Delta Transformation, Examples.	**CO1**	**Lecture**	**T1:Ch 2.1, 2.2.1, 2.2.2**
7	**L7**	Mesh analysis	Mesh analysis, Steps to be followed in Mesh Analysis, Examples.	**CO1**	**Lecture**	**T1:Ch 2.3, 2.3.1, R2: 3.5**
8	**L8**	Super Mesh analysis	Super Mesh analysis, Examples	**CO1**	**Lecture**	**T1: Ch 2.4**
9	**L9**	Nodal analysis	Nodal analysis, Steps to be followed in Nodal Analysis, Examples	**CO1**	**Lecture**	**T1: Ch 2.5, 2.5.1, R2: 3.6**
10	**L10**	Super node analysis	Super node analysis, Examples	**CO1**	**Lecture**	**T1:Ch 2.6**
11	**L11**		module 1 concluded, introduction to Module 2		**Lecture**	
			Construction of Dual networks		**Self-Learning**	**T1**
12	**L12**	Statement of Network Theorems	Superposition Theorem,Thevenin'		**Lecture**	**T1: 3.2, 3.3, 3.4, 3.6**

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			s theorem, Norton's Theorem,Maximum Power Transfer Theorem, Reciprocity Theorem, Millman's Theorem.	**CO 2**		
13	**L13**	Super position theorem explanation	Super position theorem explanation	**CO3**	**Lecture**	**T1:3.2 R2:9.4**
14	**L14**		Numerical examples on superposition theorem	**CO3**	**Lecture**	**T1:3.2**
15	**L15**		Numerical examples on superposition theorem	**CO3**	**Lecture**	**T1:3.2**
			Assignment 1	**CO1, CO2**		
16	**L16**	Thevenin's theorem explanation	Thevenin's theorem explanation	**CO3**	**Lecture**	**T1:3.3, R2: 9.5**
17	**L17**		Numerical examples on Thevenin's theorem	**CO3**	**Lecture**	**T1:3.3**
18	**L18**		Numerical examples on Thevenin's theorem	**CO3**	**Lecture**	**T1:3.3**
			Norton's Theorem,		**Self-Learning**	
19	**L19**		Maximum power transfer theorem explanation	**CO3**	**Lecture**	**T1:Ch.3.63**
		Test - 1				
20	**L20**		Discussion on Test-1		**Lecture**	
21	**L21**		Numerical examples on Maximum power	**CO3**	**Lecture**	**T1: Ch.3.63**

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			transfer theorem			
22	**L22**		Numerical examples on Maximum power transfer theorem	**CO3**	**Lecture**	**T1: Ch.3.63**
23	**L23**		Module 2 concluded, Introduction of module 3		**Lecture**	**T1:Ch8.1-8.3**
24	**L24**	Introduction to transient analysis, Initial conditions	Introduction, Network Equations, Initial conditions	**CO4**	**Lecture**	**T1:Ch8.1-8.3**
25	**L25**	Procedure for evaluating initial conditions	Procedure for evaluating initial conditions, Examples	**CO4**	**Lecture**	**T1: Ch 8.4**
26	**L25**	Transient analysis of RL circuits	Transient analysis of RL circuits(Derivation), Examples	**CO4**	**Lecture**	**T1: Ch 8.5**
27	**L27**	Transient analysis of RC circuits	Transient analysis of RC circuits(Derivation), Examples	**CO4**	**Lecture**	**T1: Ch 8.6**
			Basics of Laplace Transform		Self learning	
28	**L28**	Introduction to Laplace Transforms	Introduction, Laplace Transformation, Laplace transform of some important functions	**CO4**	**Lecture**	**T1:Ch 9.1, 9.2, 9.3**
29	**L29**	Transformed circuit, Laplace transform and time domain solution for RL network	Transformed circuit, R,L,C, Resistor-Inductor circuit (Derivation), Examples	**CO4**	**Lecture**	**T1: Ch 9.4, 9.5**
30	**L30**	Laplace transform and time domain solution for RC network	Laplace transform and time domain solution for RC network(Derivation) , Examples	**CO4**	**Lecture**	**T1: Ch 9.6**
			Assignment 2			

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31	**L31**		Solving differential equations using Laplace Transforms	**CO4**	**Lecture**	**R2: Ch:7.4**
32	**L32**		Numerical Examples	**CO4**	**Lecture**	**T1**
33	**L33**		Module 3 concluded, introduction of module 4		**Lecture**	**T1**
		Test 2				
34	**L34**		Discussion on Test 2		**Lecture**	
35	**L35**		Introduction to Two port networks, Open circuit impedance parameters	**CO5**	**Lecture**	**T1:Ch 11.1-11.2**
37	**L36**		Z parameters	**CO5**	**Lecture**	**T1:Ch 11.3**
38	**L37**		Transmission parameters	**CO5**	**Lecture**	**T1:Ch 11.4**
39	**L38**		Hybrid Parameters	**CO5**	**Lecture**	**T1:Ch 11.6**
40	**L39**		Numerical Examples	**CO5**	**Lecture**	**T1:Ch 11.12**
46	**L40**		**Concluding the course and discussion on END term exam**		**Lecture**	

Topics relevant to "SKILL DEVELOPMENT": Network Theorems, Transient Analysis and Two-port networks **for Skill Development through Problem Solving methodologies. This is attained through the Assignment as mentioned in the assessment component.**

ASSESSMENT SCHEDULE FOR THEORY COMPONENT:

Sl.no	**Assessment type**	**Contents**	**Course outcome Number**	**Duration In Hours**	**Marks**	**Weightage**	**Venue, DATE &TIME**
1.	Assignment	Module-1	1	10 Min	30	15%	
2.	MID- Term	Module-1,2 (two	1,4	1 hr.	50	25%	

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		topics)					
3.	Quiz	Module 3	3	10 Min	20	10%	
4.	End Term Final Exam	Module-1,2,3,4,	1,2,3,4	3 hr.	100	50%	

COURSE CLEARANCE&EVALUATION CRITERIA:

A minimum of 75% attendance is required for both lab and theory separately to attend the end term exam. Make-up policy will be only as per academic regulation.

MethodofAssessment forCourseswithCreditStructure(L –T –0)or(L– 0–0)			
ComponentsofContinuousAssessments		**Weightage(% of TotalMarks)**	**DurationofAssessment**
1.	MidTerm	25%	1.5hour
2.	ThisComponentofcontinuousassessmentshallconsistofatleastTWO(02)of thefollowing: (1) Assignment(s) (2) Quiz	25%	NA
3.	EndTermFinalExaminations	50%	3hours
Total		**100%**	

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS:

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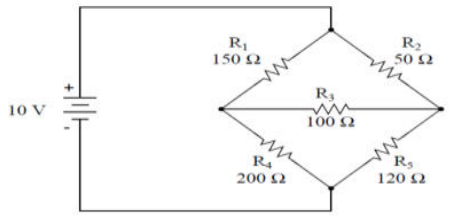
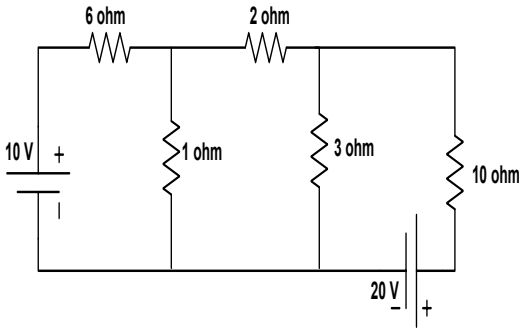
SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1.	It is possible to calculate the proper values of resistors necessary to form one kind of network delta or star (Δ or Y) that behaves identically to the other kind. A prime application for Δ-Y conversion is in the solution of unbalanced bridge circuits, such as the one below:  a. List the number of star and delta connections in the bridge circuit. Find the total current which flows through the circuit using Δ-Y conversion.	8	CO1	Comprehension
2.	The "Mesh Current" method of network analysis works well to calculate currents in any branch of the circuits. Take this circuit, for example:  Write the KVL equations for this circuit, by assuming mesh current directions, and then solve for the current through 1 ohm resistor.	8	CO1	Comprehension

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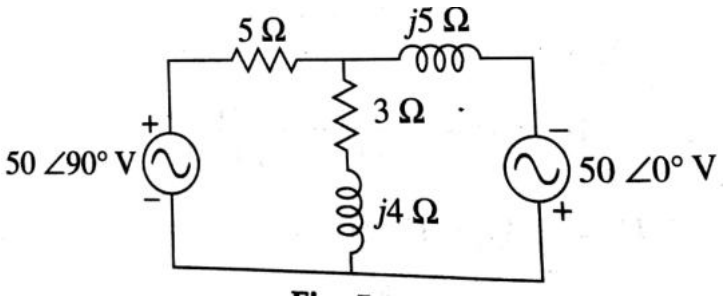
3.	In a star-connected, three-phase system, the line voltage is equal to $\sqrt{3}$ times the phase voltage. Also the line current is equal to the phase current. In this type of system, three coils, each having a resistance of 8 Ω and 0.02 H respectively are connected in star across 3-ø, 230 V, 50 Hz supply. List the unknown parameters and find the listed parameters.	10	CO5	Comprehension
4.	a. The frequency response H(jw) is a function that relates the output response to a sinusoidal input at frequency w. we can separate H(jw) into its magnitude and its phase component. Find the frequency response of a system H(s) = $\frac{s+2}{s+8}$ then find magnitude and phase component response y(t) for x(t) = sin (314t-120^0).	5	C04	Comprehension
5.	The current in any given branch of a multiple-source circuit can be found by determining the currents in that particular branch produced by each source acting alone, with all other sources replaced by their internal impedances. The total current in the given branch is the phasor sum of the individual source currents in that branch. Find the current through the 3 + j4 ohm impedance in the following figure. 	10	C03	Comprehension

Target set for course Outcome attainment:

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Sl. No.	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	CO1	Explain various network reduction techniques.	50 %
02	CO2	State various network theorems.	50 %
03	CO3	Explain Superposition theorem, Thevenin's theorem and Maximum power transfer theorem.	50 %
04	CO4	Discuss the behavior of RL and RC circuits for DC and AC excitation.	50 %
05	CO5	Discuss the parameters of two port network and relation between voltage, current and power relations in a poly phase circuits.	50 %

kdkale

Signature of the course Instructor Mrs. Aruna M

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

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Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
1	Over View of the course			
2	Module : 01			
3	Module: 02			
4	Assignment			
5	Mid Term Exam			
6	Module:03			
7	Module:04			
8	Quiz			

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Program Outcome Attainment:

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

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Name and signature of the Course Instructor:

MR. KIRAN DHANAJI KALE

D.A.C. observation and approval:

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review,	grasping the meaning of information

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	select, summarize, translate	
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

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Presidency University Act, 2013 of the Karnataka Act No. 41 of 2013 | Established under Section 2(f) of UGC Act, 1956
Approved by AICTE, New Delhi

School of Engineering

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Student Centric Methods for Winter Semester AY 2022-23

Year: 2022-23 **Semester: II** **Section: 1ECE3**

Course Title **: NETWORK THEORY**

Course Code **: ECE 2004**

Instructor In-Charge **: Dr.BALAJI K.A**

Instructors **: Dr.BALAJI K.A**

1. EXPERIENTIAL LEARNING **: NOT APPLICABLE**

2. PROBLEM SOLVING METHODOLOGIES:

Name of the Topic: TUTORIAL -1 on 10th Febrauary 2023

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Remarks: The students have learned how to calculate Voltage and current. This activity has helped the students to enhance their problem solving & analytical skill.

3. PARTICIPATIVE LEARNING **: QUIZ**

Offline Quiz conducted on 13:03:2023

Tittle :Module 1-4

Total :58

Present: 56

Absent: 02

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S.I No	Student Roll Number	Student Name	Attendence
1	20221ECE0072	SINCHANA B S	P
2	20221ECE0317	AMBARISH K	P
3	20221ECE0215	BHOOMIKA B	P
4	20221ECE0106	AMRUTHA S MALAGAR	P
P	20221ECE0107	BHAVANI S MALAGAR	P
P	20221ECE0108	BHUVAN CHANDRA M	P
P	20221ECE0109	MANSI GAUTAM	P
8	20221ECE0110	NEERAJA H C	P
9	20221ECE0111	RAVIKUMAR R	P
10	20221ECE0112	SIDDESH B S	P
11	20221ECE0216	BALAJI BHARGAV R	P
12	20221ECE0217	TEJUS M D	P
13	20221ECE0113	AKSHATA JITENDRA DARJI	P
14	20221ECE0114	ANUSHREE K N	P
15	20221ECE0115	C ARCHANA	P
16	20221ECE0116	BHARATH N N	P
17	20221ECE0117	CHAITAN TALEKAR	P
18	20221ECE0118	CHAITRA C	P
19	20221ECE0119	CHIRAAG S J	P
20	20221ECE0120	DARSHAN N	P
21	20221ECE0121	DARSHAN Y	P
22	20221ECE0122	DHEERAJ M RAY	P
23	20221ECE0123	G BHARGAV	P
24	20221ECE0124	GNANESH M C	P
25	20221ECE0125	HARSHITHA C	A
26	20221ECE0126	HARSHITHA C N	P
27	20221ECE0127	KANNIKA SHRIDHAR BELLAMKONDI	P
28	20221ECE0128	KOWSHIK B H	P
29	20221ECE0129	KRISHNAVENI M	P
30	20221ECE0130	KUMUDHINI S	P
31	20221ECE0131	KISHORE KUMAR GACHINAMANI	P

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32	20221ECE0132	LALITHASHREE M	A
33	20221ECE0133	LIKHITHA R K	P
34	20221ECE0134	MANASA B S	P
35	20221ECE0135	MANOJ K S	P
36	20221ECE0136	MAYOOR S	P
37	20221ECE0137	MONISH M N	P
38	20221ECE0138	MOHAMMED TOUFIQ SHAHAPUR	P
39	20221ECE0139	MOKSHITA A	P
40	20221ECE0140	MONIKA C	
41	20221ECE0141	MAHADEV G S	P
42	20221ECE0142	NAVYA G	P
43	20221ECE0143	N C SHOBHA	P
44	20221ECE0144	OMKAR S	P
45	20221ECE0145	PRABHURAJ BHAVIKATTI	P
46	20221ECE0146	PRAGNA A KAREGOUDAR	P
47	20221ECE0147	PRAJWAL B N	P
48	20221ECE0148	RAHUL T U	P
49	20221ECE0149	RAHUL G	P
50	20221ECE0150	REVANTH H M S	P
51	20221ECE0151	RISHITHA T R	P
52	20221ECE0152	RETHIKA SAI R	P
53	20221ECE0153	S SHOBITH	P
54	20221ECE0154	SHRIYA L	P
55	20221ECE0155	SRIKANTH V R	P
56	20221ECE0156	SUSHIL	P
57	20221ECE0157	VARUN A	P
58	20221ECE0158	VARUN K P	P

QUIZ QUESTIONS

1) Which of the following expression is true in case of Z parameters? (C.O.No.1) [Knowledge]

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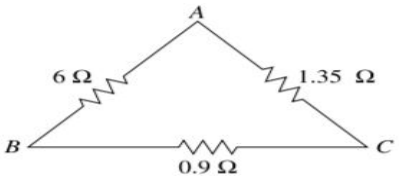
a)$V_1 = Z_{11} V_1 + Z_{12} I_2$
b) $V_1 = Z_{11} I_1 + Z_{12} V_2$
c) $V_1 = Z_{11} I_1 + Z_{12} I_2$
d) $V_2 = Z_{11} I_1 + Z_{12} I_2$

2) While applying superposition theorem (Ideal Case) when voltage source is turned off it is replaced by _____ and when current source is turned off it is replaced by _____

a) Open circuit, Short Circuit
b) Short circuit, Open Circuit
c) Low resistance in series, very high resistance in series
d) High resistance in series, very low resistance in series

(C.O.No.1) [Knowledge]

3) Calculate the equivalent resistance from the following diagram (C.O.No.1) [Knowledge]

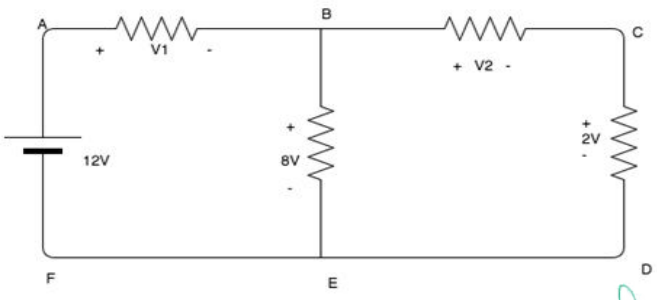


a) 1.64 Ohm
b) 2 Ohm
c) 100 Ohm
d) None of the above

4. The expression of current in R-L circuit is? (C.O.No.1) [Knowledge]

a) i=(V/R)(1+exp((R/L)t))
b) i=-(V/R)(1-exp((R/L)t))
c) i=-(V/R)(1+exp((R/L)t))
d) i=(V/R)(1-exp((R/L)t))

5. Calculate the value of V1 and V2. (C.O.No.1) [Knowledge]



a) 4V, 6V
b) 5V, 6V

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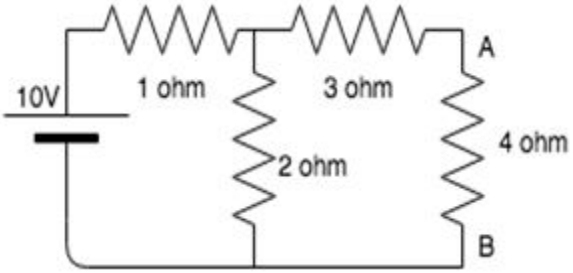
c) 6V, 7V
d) 7V, 8V

6) KCL deals with the conservation of___ and it is applied at _____ (C.O.No.1) [Knowledge]
a) Momentum & Loop
b) Mass & Node
c) Potential Energy & Loop
d) Charge & Node

7) Once the circuit is transformed to a voltage source where will the resistance be connected?
a) In series with the voltage source
b) In parallel with the voltage source
c) The resistance is removed from the circuit
d) Resistance is multiplied by 10 and connected in series with the source (C.O.No.1) [Knowledge]

8) Calculate the Thevenins resistance across the terminal AB for the following circuit.



a) 4.34 ohm
b) 3.67 ohm
c) 3.43 ohm
d) 2.32 ohm (C.O.No.1) [Knowledge]

9) While computing the Thevenin equivalent resistance and the Thevenin equivalent voltage, which of the following steps are undertaken?
a) Both the dependent and independent voltage sources are short-circuited and both the dependent and independent current sources are open-circuited
b) Both the dependent and independent voltage sources are open-circuited and both the dependent and independent current sources are short-circuited
c) The dependent voltage source is short-circuited keeping the independent voltage source untouched and the dependent current source is open-circuited keeping the independent current source untouched
d) The dependent voltage source is open-circuited keeping the independent voltage source untouched and the dependent current source is short-circuited keeping the independent current source untouched

(C.O.No.1) [Knowledge]

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10) In a parallel circuit, with a number of resistors, the voltage across each resistor is _____

a) The same for all resistors
b) Is divided equally among all resistors
c) Is divided proportionally across all resistors
d) Is zero for all resistors

(C.O.No.1)

[Knowledge]

11)Condition of reciprocity in Y-parameter representation is

a) Y11 = Y12.
b) Y12 = Y21.
c)Y11 = Y22.
d)Y12 = Y22.

(C.O.No.1) [Knowledge]

12) Which is the correct condition of symmetry observed in z-parameters?

a. $z_{11} = z_{22}$
b. $z_{11} = z_{12}$
c. $z_{12} = z_{22}$
d. $z_{12} = z_{21}$

(C.O.No.1) [Knowledge]

13) If many branches or nodes are present in a parallel configuration in a network, which method approves to be extensively beneficial for network analysis ?

a. Mesh method
b. Node method
c. Both a and b
d. None of the above

(C.O.No.1) [Knowledge]

Remarks: The students have participated in the quiz and explore about the knowledge in network analysis has helped the students to enhance their problem solving & analytical skill.

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Signature of Instructors: 

Signature of Instructor In-Charge: 

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Course Code: ECE3007	**Course Title:** Control System (Only for 2020 and 2021) **Type of Course:** Program Core & Theory only	**L- P- C**	4	0	4
Version No.	1.0				
Course Pre-requisites	**Fundamental concepts of network theory, differential equations and Laplace transforms.**				
Anti-requisites	**NIL**				
Course Description	**The purpose of this course is to enable the students about the importance of control system engineering and to develop the basic abilities of modelling and analyzing the control system. The course is both conceptual and analytical in nature and needs fair knowledge of Mathematical and computing. The course develops the critical thinking and analytical skills. The course also enhances the programming and simulation abilities through assignments.**				
Course Objectives	**The objective of the course is to familiarize the learners with the concepts of Control System and attain the SKILL DEVELOPMENT through PROBLEM SOLVING.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** (1) Describe various systems and their representations using Block diagrams and Signal Flow graphs (2) Employ time domain analysis to determine the transient performance parameters of the system. (3) Explain the system stability in the frequency domain (4) Identify the need of State Space Representation				
Course Content:					

Module 1	Modelling of Systems	Assignment/quiz	Knowledge and Comprehension	**14 Sessions**

Topics:

Basic elements in control systems – Open and closed loop systems – Transfer function. Mathematical Modeling of Systems: Electrical Systems, Mechanical Systems [Translational and Rotational Mechanical Systems]. Electrical analogy of mechanical Systems– Force Voltage and Force Voltage Analogy. Block Diagram - Block diagram reduction techniques – Signal flow graphs – Mason's Gain Formula.

Module 2	Time Response Analysis	Assignment/quiz	Comprehension	**11 Sessions**

Topics:

Time response – Transient and Steady State Response. Order and Type of System. Concept of Poles and Zeros. Unit Impulse, Unit Step and Unit Ramp Response of First Order Systems. Unit Step

Response of Second Order Systems. Time domain specifications – Peak Time, Rise Time, Maximum Overshoot, Settling Time, Steady State Error, Static Error Constants.

Module 3	Frequency domain analysis and stability	Assignment/quiz	Comprehension	**17 Sessions**

Topics:

Stability of Control Systems: Characteristics equation –Routh Hurwitz criterion

Root Locus – Stability analysis using root locus

Frequency response – Frequency Response Specifications – Gain Margin, Phase Margin, Bandwidth, Resonant Peak, Resonant Frequency.

Bode plot – Constant Gain, Simple and Repeated Pole, Simple and Repeated Zero.

Polar plot – Nyquist Stability Criterion.

Module 4	Introduction of Modern Control System	Case study	Comprehension	**11 Sessions**

Topics:

Concept of State, State variables & State model, Modeling of electrical and mechanical systems in state space. State Transition Matrix, Solution of state space equation. Concepts of controllability and observability

Targeted Application & Tools that can be used:

Application of this course is in the field of process control industries, automobile industries, aerospace etc.

1. **MATLAB/ SIMULINK**
2. **Octave**

Text Book(s):

1. **Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 5th edition.**
2. **Norman S Nise, "Control Systems Engineering", Wiley, 7th edition.**

Reference(s):

Reference Book(s):

1. **Richard C Dorf, Robert H Bishop, "Modern Control Systems", Pearson Education, 11th Edition**
2. **Benjamin Kuo, "Automatic Control Systems", PHI, 7th Edition**

Online Resources (e-books, notes, ppts, video lectures etc.):

3. Class Notes, Class Slides
4. NPTEL ONLINE Videos: Lecture by Prof. Ramkrishna Pasumarthy, IIT Madras
   https://onlinecourses.nptel.ac.in/noc22_ee31/preview
5. Presidency University Library Link
   https://presiuniv.knimbus.com/user#/home
6. https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-1-introduction-and-basic-concepts/
7. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/lecture-2-discrete-time-dt-systems/

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8. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/lecture-10-feedback-and-control/

E-content:

1. M. Phister, "Digital Control Systems-Present and Future," in IRE Transactions on Industrial Electronics, vol. PGIE-11, pp. 44-47, Dec. 1959, doi: 10.1109/IRE-IE.1959.5007732. https://ieeexplore.ieee.org/document/5007732
2. J. V. Wallbank, S. Singh and S. Walters, "An introduction to the implementation of digital control — Leading to the control of electrical power systems," 2017 52nd International Universities Power Engineering Conference (UPEC), 2017, pp. 1-5, doi: 10.1109/UPEC.2017.8232032. https://ieeexplore.ieee.org/abstract/document/8232032
3. V. Dimitrov, N. Hinov and K. Genev, "Synthesis and Implementation of a Digital Control System for a Buck DC-DC Converter," 2021 29th National Conference with International Participation (TELECOM), 2021, pp. 161-166, doi: 10.1109/TELECOM53156.2021.9659658. https://ieeexplore.ieee.org/document/9659658
4. S. V. Bell, T. M. Murray and K. T. Duncan, "Design of direct digital control systems for building control and facilities management," IEEE Proceedings of the SOUTHEASTCON '91, 1991, pp. 674-676 vol.2, doi: 10.1109/SECON.1991.147841. https://ieeexplore.ieee.org/document/147841

Topics relevant to "SKILL DEVELOPMENT": Laplace Transform, Routh-Hurwitz Criterion, Bode Plot, Nyquist Plot, State-space techniques for **Skill Development** through **Problem Solving methodologies**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mrs. Priyanka Ray
Recommended by the Board of Studies on	BOS Meeting NO: 15th, Dated BOS 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/22

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ACA-2 [2022] COURSE HANDOUT

SCHOOL: Engineering **DEPT.:**ECE **DATE OF ISSUE:** 27/08/2022

NAME OF THE PROGRAM **:**B. Tech (ECE)

P.R.C.APPROVAL REF. **:** PU/AC-18.4/ECE15/ECE/2022-24

SEMESTER/YEAR **:5/3**

COURSE TITLE & CODE **:**Control Systems & ECE3007

COURSE CREDIT STRUCTURE **:**4 Credits (L = 4, P = 0, C= 4)

CONTACT HOURS **:**4 Hours/Week

COURSE INSTRUCTORS **:** Mr. Tony

INSTRUCTOR INCHARGE **:** Mr. Tony

PROGRAM OUTCOMES:

Graduates of the B.Tech. Program in Electronics and Communication Engineering will be able to:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.(H)

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.(H)

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.(M)

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.(M)

PO5. 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.(M)

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.(L)**

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES:

The student should have fundamental concepts of network theory, differential equations and Laplace transforms.

COURSE DESCRIPTION:

The purpose of this course is to enable the students about the importance of control system engineering and to develop the basic abilities of modelling and analyzing the control system. The course is both conceptual and analytical in nature and needs fair knowledge of Mathematical and computing. The course develops the critical thinking and analytical skills. The course also enhances the programming and simulation abilities through assignments.

COURSE OBJECTIVE:

The objective of the course is to familiarize the learners with the concepts of Control System and attain the SKILL DEVELOPMENT through PROBLEM SOLVING.

COURSE OUTCOMES: On successful completion of the course the student shall be able to:

CO1: Describe various systems and their representations using Block diagrams and Signal Flow graphs

CO2: Employ time domain analysis to determine the transient performance parameters of the system.

CO3: Explain the system stability in the frequency domain

CO4: Identify the need of State space representation

MAPPING OF C.O. WITH P.O: [H-HIGH, M- MODERATE, L-LOW]

CO NO.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 10
1	H	H		M		L
2	H	H			M	L
3	H	H	M		M	L
4	H	H				L

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COURSE CONTENT(SYLLABUS):

Module-I: MODELLING OF SYSTEMS [14Hrs] [Bloom's level selected: Knowledge & Comprehension**]**

Basic elements in control systems – Open and closed loop systems – Transfer function. Mathematical Modeling of Systems: Electrical Systems, Mechanical Systems [Translational and Rotational Mechanical Systems]. Electrical analogy of mechanical Systems– Force Voltage and Force Voltage Analogy. Block Diagram - Block diagram reduction techniques – Signal flow graphs – Mason's Gain Formula.

Module- II: TIME RESPONSE ANALYSIS[11Hrs] [Bloom's level selected: Comprehension**]**

Time response – Transient and Steady State Response. Order and Type of System. Concept of Poles and Zeros. Unit Impulse, Unit Step and Unit Ramp Response of First Order Systems, Unit Step Response of Second Order Systems. Time domain specifications – Peak Time, Rise Time, Maximum Overshoot, Settling Time.

Steady State Error, Static Error Constants

Module -III :FREQUENCY DOMAINANALYSIS AND STABILITY [17Hrs] [Bloom's level selected: Comprehension**]**

Stability of Control Systems: Characteristics equation –Routh Hurwitz criterion

Root Locus – Stability analysis using root locus

Frequency response – Frequency Response Specifications – Gain Margin, Phase Margin, Bandwidth, Resonant Peak, Resonant Frequency.

Bode plot – Constant Gain, Simple and Repeated Pole, Simple and Repeated Zero.

Polar plot – Nyquist Stability Criterion.

Module-IV: INTRODUCTION OF MODERN CONTROL THEORY [11Hrs] [Bloom's level selected: Comprehension]

Concept of State, State variables & State model, Modeling of electrical and mechanical systems in state space. State Transition Matrix, Solution of state space equation. Concepts of controllability and observability

SKILL SETS TO BE DEVLOPED:

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. **Ability to interpret events and results.**
4. **Ability to work as a leader and as a member of a team.**
5. **Assess errors in systems/processes/programs/computations and eliminate them.**
6. **Observe and measure physical phenomena.**

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7. **Write reports.**
8. **Select suitable equipment, instrument, materials & software**
9. **Locate faults in system/Processes/software.**
10. **Manipulative skills for setting and handling systems/Process/Issues**
11. **The ability to follow standard /Legal procedures.**
12. **An awareness of the Professional Ethics.**
13. **Need to observe safety/General precautions.**
14. **To judge magnitudes/Results/issues without actual measurement/actual contacts**

DELIVERY PROCEDURE (PEDAGOGY):

Lectures will be conducted with the aid of multi-media projector, blackboard, etc.
Assignments based on course contents will be given to the students at the end of each unit/topic and will be evaluated at regular interval

Self-Learning Topics:

Discuss Rotational mechanical systems and analogy, Describe AC Servo motor.

Controller types

Experiential Learning Topics:

Finding the response of systems using MATLAB.

Using MATLAB to plot the root locus and Bode Plot

Using MATLAB to verify the response of a system in state space

REFERENCE MATERIALS:

1. **Text Book(s):**
   1. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 5th Edition
   2. Norman S Nise, "Control Systems Engineering", Wiley, 7th Edition
2. **Reference Books**
   1. Richard C Dorf, Robert H Bishop, "Modern Control Systems", Pearson Education, 11th Edition
   2. Benjamin Kuo, "Automatic Control Systems", PHI, 7th Edition
3. **Other Resources:**
   1. Class Notes, Class Slides
   2. NPTEL ONLINE Videos: Lecture by Prof. RamkrishnaPasumarthy, IIT Madras
      https://onlinecourses.nptel.ac.in/noc22_ee31/preview
   3. Presidency University Library Link
      https://presiuniv.knimbus.com/user#/home
   4. https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-1-introduction-and-basic-concepts/

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5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/lecture-2-discrete-time-dt-systems/
6. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/lecture-10-feedback-and-control/

4. E Content:

5. M. Phister, "Digital Control Systems-Present and Future," in IRE Transactions on Industrial Electronics, vol. PGIE-11, pp. 44-47, Dec. 1959, doi: 10.1109/IRE-IE.1959.5007732. https://ieeexplore.ieee.org/document/5007732
6. J. V. Wallbank, S. Singh and S. Walters, "An introduction to the implementation of digital control — Leading to the control of electrical power systems," 2017 52nd International Universities Power Engineering Conference (UPEC), 2017, pp. 1-5, doi: 10.1109/UPEC.2017.8232032. https://ieeexplore.ieee.org/abstract/document/8232032
7. V. Dimitrov, N. Hinov and K. Genev, "Synthesis and Implementation of a Digital Control System for a Buck DC-DC Converter," 2021 29th National Conference with International Participation (TELECOM), 2021, pp. 161-166, doi: 10.1109/TELECOM53156.2021.9659658. https://ieeexplore.ieee.org/document/9659658
8. S. V. Bell, T. M. Murray and K. T. Duncan, "Design of direct digital control systems for building control and facilities management," IEEE Proceedings of the SOUTHEASTCON '91, 1991, pp. 674-676 vol.2, doi: 10.1109/SECON.1991.147841. https://ieeexplore.ieee.org/document/147841

Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

GUIDELINES TO STUDENTS:

- The students are advised to be very much regular to the classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Microsoft teams on a regular basis to access the supporting materials shared by the course instructors.
- Control Systems is a problem-based course where mostly practicing the problems is very much important than reading the theory and hence for studying the concepts, any book can be followed such as mentioned in reference books or else you can download pdf notes from NPTEL.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.
- Students are required to strictly adhere to assignment deadlines.
- Students are required to actively participate in classroom discussions and other activities which is planned in the classroom.

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- Students are required to have minimum of 75% of attendance to be eligible to attend exam

COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF SESSIONS
01	Over View of the course			01
02	Module : 01			14
03	Quiz 1/ Assignment 1			---
04	Module : 02			11
05	Mid Term Examination			NA
06	Mid Term Paper Discussion			01
07	Module:03			17
08	Quiz 2/ Assignment 2			---
09	Module 4			11
10	End Term Examination			NA

SCHEDULE OF INSTRUCTION:

Module: 1MODELLING OF SYSTEMS

Sl. no	*Date*	*Lesson Title*	*Topics*	*Course Outcome Number*	*Delivery Mode*	*Reference*
1	L1	Program Integration/ Course Integration				
2	L2	Control System	Introduction, open loop and closed loop control systems. Review of Laplace Transform	CO1	Chalk/ Board/ Slides	T1, T2
3	L3	Mathematical Modelling	Transfer Function, Mathematical Modelling of Electrical Systems – Part 1	CO1	Chalk/ Board/ Slides	T1, T2
4	L4	Mathematical Modelling	Mathematical Modelling of Electrical Systems – Part 2	CO1	Chalk/ Board/ Slides	T1, T2
5	L5	Mathematical Modelling	Mathematical Modelling of Translational Mechanical Systems – Part 1	CO1	Chalk/ Board/ Slides	T1, T2

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6	L6	Mathematical Modelling	Mathematical Modelling of Translational Mechanical Systems – Part2	CO1	Chalk/ Board/ Slides	T1, T2
7	L7	Mathematical Modelling	Mathematical Modelling of Translational Mechanical Systems – Part3	CO1	Chalk/ Board/ Slides	T1, T2
8	L8	Mathematical Modelling	Mathematical Modelling of Rotational Mechanical Systems	CO1	Chalk/ Board/ Slides	T1, T2
9	L9	Electrical Analogy of Mechanical System	Force Voltage Analogy		Chalk/ Board/ Slides	T1, T2
10	L10	Electrical Analogy of Mechanical System	Force Current Analogy	CO1	Chalk/ Board/ Slides	T1, T2
11	L11	Block Diagram Reduction	Block Diagram Reduction Rules	CO1	Chalk/ Board/ Slides	T1, T2
12	L12	Block Diagram Reduction	Block diagram reduction Problems – Part 1	CO1	Chalk/ Board/ Slides	T1, T2
13	L13	Block Diagram Reduction	Block diagram reduction Problems – Part 2	CO1	Chalk/ Board/ Slides	T1, T2
14	L14	Signal Flow Graphs	Signal Flow Graph, Loop, Path, Mason's Gain Formula	CO1	Chalk/ Board/ Slides	T1, T2
15	L15	Signal Flow Graphs	Solving problems based on Signal Flow Graph	CO1	Chalk/ Board/ Slides	T1, T2
16	L16	Self Study	DC Motor and AC Servo motor	CO1	Chalk/ Board/ Slides	T1, T2
Module 1 completed						

Module: 2TIME RESPONSE ANALYSIS

Sl. No	***Session no***	***Lesson Title***	***Topics***	***Course Outcome Number***	***Delivery Mode***	***Reference***
1	L17	Time Response	Standard Test Signals, Order and Type of a System, Unit Step, Unit Impulse Response of First Order System	CO2	Chalk/ Board/ Slides	T1, T2
2	L18	Time Response	Unit Ramp Response of a First Order System, Numerical based on time response	CO2	Chalk/ Board/ Slides	T1, T2

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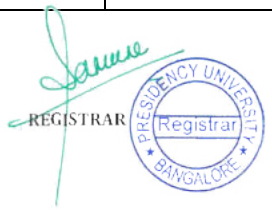
3	L19	Time response of Second Order System	Second Order System, Damping- Underdamped, Critically damped, Undamped, Overdamped second order system	CO2	Chalk/ Board/ Slides	T1, T2
4	L20	Time response of second order system	Impulse Response of a second order undamped, Critically damped and underdamped System	CO2	Chalk/ Board/ Slides	T1, T2
5	L22	Time response of second order system	Step Response of a Second order Undamped and Underdamped System	CO2	Chalk/ Board/ Slides	T1, T2
6	L23	Time response of second order system	Time Domain Specifications: Peak Time, Rise Time, Maximum Overshoot, Settling Time	CO2	Chalk/ Board/ Slides	T1, T2
7	L24	Time response of second order system	Numerical based on Time domain Specifications	CO2	Chalk/ Board/ Slides	T1, T2
8	L25	Time response of second order system	Numerical based on Time domain Specifications	CO2	Chalk/ Board/ Slides	T1, T2
9	L26	Steady State Error	Steady State Error: Static Error Constants: Position Error Constant, Velocity Error Constant, Acceleration Error Constant	CO2	Chalk/ Board/ Slides	T1, T2
10	L27	Steady State Error	Numerical Based on Steady State Error	CO2	Chalk/ Board/ Slides	T1, T2
11	L28	Revision	Revision for Mid Term Examination			
12	L29	**Experiential Learning Topics**	Time Response of Systems: Verification Using MATLAB	CO2	MATLAB	
		Self-Learning Topic	Controller Types			T1, T2
Module 2 completed						

Module: 3FREQUENCY DOMAIN ANALYSIS AND STABILITY

Sl. No	*Session no*	*Lesson Title*	*Topics*	*Course Outcome Number*	*Delivery Mode*	*Reference*
1	L30		Discussion of Mid Term Examination			
2	L31	Stability of Control Systems	BIBO Stability: Location of Poles and Stability, Routh Hurwitz Criterion	CO3	Chalk/ Board/ Slides	T1, T2
3	L32	Stability of Control Systems	Routh HurwitzCriterion : Special Cases	CO3	Chalk/ Board/ Slides	T1, T2
4	L33	Stability of Control Systems	Numerical of RH Criterion	CO3	Chalk/ Board/ Slides	T1, T2
5	L34	Root Locus	Relative Stability: What is root locus? Rules for construction of root locus	CO3	Chalk/ Board/ Slides	T1, T2
6	L35	Root Locus	Rules for construction of root locus continued	CO3	Chalk/ Board/ Slides	T1, T2
7	L36	Root Locus	Root Locus :Construction Examples	CO3	Chalk/ Board/ Slides	T1, T2
8	L37	Root Locus	Root Locus :Construction Examples	CO3	Chalk/ Board/ Slides	T1, T2
9	L38	Frequency Response Specifications	Gain Margin, Phase Margin, Bandwidth, Resonant Peak, Resonant Frequency	CO3	Chalk/ Board/ Slides	T1, T2
10	L39	Bode Plot	Introduction to Bode Plot: Single Pole at Origin, Single Zero at Origin, Multiple Poles and Zeros at Origin, Simple Pole not at origin, Simple Zero not at origin. Repeated Poles and Zeros not at origin	CO3	Chalk/ Board/ Slides	T1, T2
11	L40	Bode Plot	Construction of Bode Plot Examples: Gain Margin and Phase Margin from Bode Plot	CO3	Chalk/ Board/ Slides	T1, T2
12	L41	Bode Plot	Bode Plot Construction Examples	CO3	Chalk/ Board/ Slides	T1, T2



13	L42	Polar Plot	Gain and magnitude Form, Plotting a polar plot	CO3	Chalk/ Board/ Slides	T1, T2
14	L43	Nyquist Stability Criterion	Principle of Arguments: Developing Nyquist Stability Criterion	CO3	Chalk/ Board/ Slides	T1, T2
15	L44	Nyquist Stability Criterion	Numerical Based on Nyquist Stability Criterion – 1	CO3	Chalk/ Board/ Slides	T1, T2
16	L45	Nyquist Stability Criterion	Numerical Based on Nyquist Stability Criterion – 2	CO3	Chalk/ Board/ Slides	T1, T2
17	L46	Nyquist Stability Criterion	Numerical Based on Nyquist Stability Criterion – 3	CO3	Chalk/ Board/ Slides	T1, T2
18	L47	Experiential Learning Topics:	Drawing root locus and Bode plot using MATLAB	CO3	MATLAB	
Module 3 completed						

Module: 4INTRODUCTIONTO MODERN CONTROL THEORY

Sl. no	***Session no***	***Lesson Title***	***Topics***	***Course Outcome Number***	***Delivery Mode***	***Reference***
1	L48	Concept of State Space	Concept of state, state variables and state model with an example of RLC circuit	CO4	Chalk/ Board/ Slides	T1, T2
2	L49	Modelling of Electrical Circuits in State Space	Modelling of Electrical Circuits in State Space	CO4	Chalk/ Board/ Slides	T1, T2
3	L50	Modelling of Mechanical Systems in State Space	Modelling of Mechanical Systems in State Space	CO4	Chalk/ Board/ Slides	T1, T2
4	L51	State Space Modelling	State Space Modelling of Systems given as a differential equation or transfer function	CO4	Chalk/ Board/ Slides	T1, T2

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5	L52	State Space Modelling	Transfer function form a State Space Model	CO4	Chalk/ Board/ Slides	T1, T2
6	L53	Solution of State Space Equation	State Transition Matrix, Properties of STM	CO4	Chalk/ Board/ Slides	T1, T2
7	L54	Solution of State Space Equation	Solution using STM	CO4	Chalk/ Board/ Slides	T1, T2
8	L55	Controllability and Observability	Kalman's Test for Controllability and Observability	CO4	Chalk/ Board/ Slides	T1, T2
9	L56	Controllability and Observability	Numericals based on Observability and Controllability	CO4	Chalk/ Board/ Slides	T1, T2
10	L57	**Experiential Learning Topics:**	Using MATLAB to find the response of a system represented by state space model	CO4	MATLAB	
11	L58	**Experiential Learning Topics:**	Using MATLAB to find the response of a system represented by state space model	CO4	MATLAB	
12	L59	Revision				

Topics relevant to "SKILL DEVELOPMENT": Laplace Transform, Routh-Hurwitz Criterion, Bode Plot, Nyquist Plot, State-space techniques for **Skill Development** through **Problem Solving methodologies**. This is attained through the **Assignment** as mentioned in the assessment component.

ASSESSMENT SCHEDULE:

Sl. no	Assessment type	Contents	Course outcome Number	Duration In Minutes	Marks	weightage	Venue,DATE &TIME
1.	Assignment-1	Module-1	CO1	30 minutes	15	7.5%	---

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2.	MidTermExamination	Module-1 and 2	CO1, CO2	90 minutes	60	30%	03/11/2022 - 07/11/2022
3.	Assignement2	Module-3	CO3	30 minutes	15	7.5%	
4.	Assignment Review of digital / e-resourcesfrom Pres. Univ. linkgiven in the References Section -(Mandatory to submitscreenshotaccessing digital resource. Otherwiseitwill not beevaluated)	Paper 1: https://ieeexplore.ieee.org/document/5007732 Paper 2: https://ieeexplore.ieee.org/abstract/document/8232032 Paper 3: https://ieeexplore.ieee.org/document/9659658 Paper 4: https://ieeexplore.ieee.org/document/147841	-	---	10	5%	---
5.	End Term Final Examinations	Module-1,2,3 & 4	CO1-CO4	180 hours	100	50%	05/01/2023 – 25/01/2023

COURSE CLEARANCE CRITERIA:

- Minimum of 75% Attendance is must to take up the End Term Examination.
- Minimum of 40% score is must in internal assessment.
- Minimum of 30% in the End Term Examination.
- The Student must have secured a minimum of 40% of the AGGREGATE of the marks/ weightage of the components of the Continuous Assessments and the End Term Final Examination in the concerned Course.
- Make up policy is applicable only as per academic regulation
- There will be no make-up for ASSIGNMENT and QUIZ.

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MethodofAssessment			
ComponentsofContinuousAssessments		Weightage(% of TotalMarks)	DurationofAssessment
1.	MidTerm Examination	30%	1.5hour
2.	ThisComponentofcontinuousassessmentshallconsistofatleastTWO(02)of thefollowing: (1) Assignment(s) (2) Quiz	20%	NA
3.	EndTermFinalExaminations	50%	3hours
Total		**100%**	

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS FOR ANY DISCUSSIONS:

Interested students may contact the Instructor In-charge during the student free Hour when the Instructor is free. The Time table of the instructor will be shared with students

SAMPLE THOUGHT PROVOKING QUESTIONS

Sl. No	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1	Block diagram reduction is an essential method, which can be used to represent a complex system using a single block. If the block diagram is converted into a Signal Flow Graph which is the graphical representation of the complete block diagram, it becomes easy to find the closed loop transfer function using Mason's Gain Formula. Consider the following block diagram	10 M	CO 1	Comprehension

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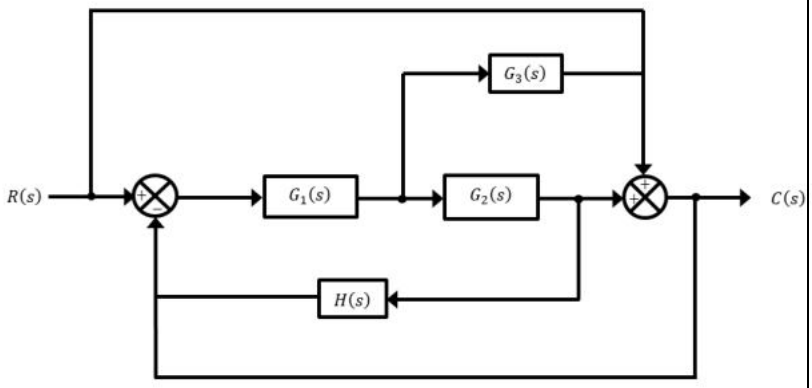

Given

$$G_1(s) = \frac{1}{s+2}$$

$$G_2(s) = \frac{2}{s+3}$$

$$H(s) = s$$

$$G_3(s) = 3$$

Mr. Rinto wants to do some analysis of the block diagram to check what will be the output if a certain input is given. For that he is planning to do a transfer function modelling so that he can use MATLAB to model the system. He finally found that the closed loop transfer function as

$$H(s) = \frac{C(s)}{R(s)} = \frac{Numerator}{Denominator}$$

What will be the numerator and denominator polynomial? Use Mason's Gain Formula

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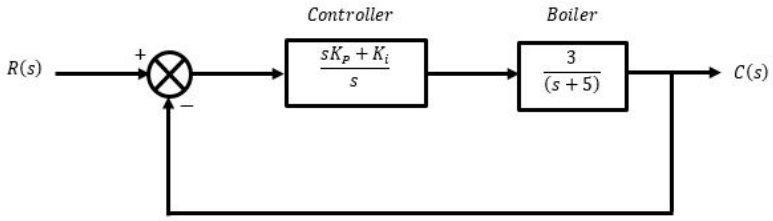
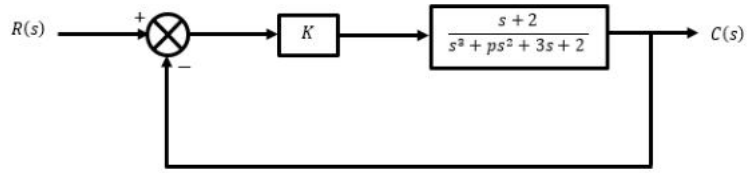
Sl. No	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
2	Suppose you are a control engineer in Kochi Refineries Limited. You are working with the temperature control of a boiler.  Your supervisor has asked you to maintain the temperature inside the boiler such that the following specifications are met Specification 1: The response when a step input is applied, have an overshoot of 5% only. Specification 2: The systems settles to the required temperature in 1 s. Estimate the controller parameters K_p and K_i which will meet the specifications given by your supervisor	10 M	CO2	Comprehension
3	Mr. Suraj is analyzing a certain system shown below.  He performed some experiments on the system and observed that the system is oscillating at a frequency of 2 rad/s. Help him deduce the value of K and p	10 M	CO3	Comprehension
4	Mr. Rinto is given a task of modelling a system in matrix form, whose differential equation is given as $$\frac{d^2y(t)}{dt^2} + 7\frac{dy(t)}{dt} + 12y(t) = 3x(t)$$	10 M	CO4	Comprehension

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	Here x(t) is the input and y(t) is the output. Identify the modelling to be used and hence model the system in that form. Now his Professor asked him to analyze the stability of the system by obtaining the poles of the system by finding the transfer function from this particular model. Deduce the transfer function and write the poles of the system. Is the system STABLE? Now the Professor wanted him to apply state feedback to meet certain criteria. In order to do so, the system should be controllable and observable. Help Mr. Rinto by checking whether the system is controllable and observable.			

Target set for course Outcome attainment:

Sl. No:	***C.O. No.***	***Course Outcomes***	***Target set for attainment in percentage***
01	CO 1	**Describe various systems and their representations using Block diagrams and Signal Flow graphs.**	50%
02	CO 2	**Employ time domain analysis to determine the transient performance parameters of the system**	50%
03	CO 3	**Explain the system stability in the frequency domain**	50%
04	CO 4	**Identify the need of State space representation**	50%

Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity	Scheduled Completion Date	Actual Completion Date	Remarks

	As listed in the course Schedule			
1	Over View of the course			
2	Module : 01			
3	Module: 02			
4	Assignment			
5	Mid Term Exam			
6	Module:03			
7	Module:04			
8	Quiz			

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment &Measures to enhance the attainment
01	CO 1	**Describe various systems and their representations using Block diagrams and Signal Flow graphs.**	50%		
02	CO 2	**Employ time domain analysis to determine the transient performance parameters of the system**	50%		
03	CO 3	**Explain the system stability in the frequency domain**	50%		
04	CO 4	**Identify the need of State space representation**	50%		

Name and signature of the Faculty member:

D.A.C. observation and approval:

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BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

SCHOOL of ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Year: 2022-2023 (Odd) **Semester:** Semester V (B. Tech.) **Section:** 5ECE-01

Course Title : Control Systems

Course Code : ECE3007

Type of Skill : Skill Development

Type of Activity : Problem Solving

Instructor in Charge : **Mr. Tony Aby Varkey M**

Instructor for Section : **Mr. Tony Aby Varkey M**

Details about the activity : This is an assignment where in the student have to solve the question using pen and paper using the methods discussed in class.

In question 1, the student is supposed to find the transfer function of the electrical system with the element values given to him/her. Then he/she should simulate the obtained transfer function in MATLAB® to obtain the step response of the system. Then the student is supposed to wire the circuit in NI MULTISIM Live® and find the transient response for a dc voltage as input and verify whether both the simulations produce the same output. The tasks to be done are given in detail in the question itself.

In question 2, the student is supposed to find the transfer function of the given translational mechanical system and hence simulate the transfer function in MATLAB® to obtain the step response.

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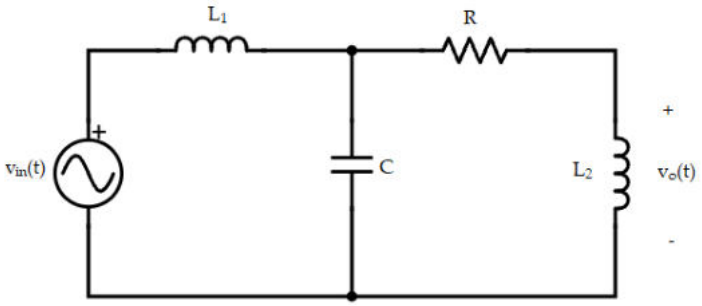
Assignment No: 01

Submit on or before 11:59 pm, 06/10/2022 (CAMU and Teams)

Hardcopy to be submitted on 07/10/2022 in class

ECE3007 Control Systems

Question1: Consider the circuit shown below



The values of L_1, L_2, C, and R are given in the table in the next page. Choose accordingly.

Task 1: Draw the circuit replacing the values of L_1, L_2, C, and R

Task 2: Find the transfer function of the circuit

Task 3: Simulate the circuit in NI MULTISIM Live and plot the output when the input is 1 V dc.[Make sure you use a good time step and final time]

Task 4: Using the transfer function that you found in task 3, find the step response of the system using MATLAB. The time axis for both NI MULTISIM and MATLAB should be the same

Note: The answer should be written neatly. Use pencil and scale to draw the circuit. Each page should have your register number and name. Scan the written part neatly. The screen shot of the MULTISIM live should be proper with the file name as register number and inside the circuit your name and register number should be present. The link to the simulation should be given in the submission. You have to come and show me the simulation in person.

The MATLAB Code should be like this

```
clc;
clear;
close all;
diary Circuit1
disp('NAME:  ')
disp('ROLL NO:  ')
disp('SEMESTER AND SECTION: ')
Date_Time = datestr(cputime)
```

Your code here

```
diary off
```

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Sl. No:	*Reg No:*	*Name of Student*	L_1	L_2	*C*	*R*
1	20201ECE0001	BANGARU VIGNESH	1	2	3	9
2	20201ECE0002	DHEERAJ M G	2	4	3	8
3	20201ECE0004	JAHNAVI N	3	6	3	7
4	20201ECE0005	M MANOJ KUMAR	4	8	3	6
5	20201ECE0006	RITESH POLE S	5	1	3	5
6	20201ECE0007	CHOWDAM UDAY	6	3	4	4
7	20201ECE0008	SUMANTH REDDY M S	7	5	4	3
8	20201ECE0010	ARUN KRISHNA A	8	7	4	2
9	20201ECE0011	CHIRAG V	9	9	4	1
10	20201ECE0012	GUNDU HARI KRISHNA REDDY	1	4	4	5
11	20201ECE0013	KUCHI NITHIN	2	6	5	6
12	20201ECE0014	GANGAVARAM DWARAKANATHA REDDY	3	8	5	7
13	20201ECE0016	HARSHITH R PRASAD	4	1	5	3
14	20201ECE0017	RACHANA SU	5	3	5	2
15	20201ECE0018	GUDDETI UDAY KIRAN REDDY	6	5	5	1
16	20201ECE0019	PRAGATHI S BHANDARE	7	2	6	6
17	20201ECE0023	DAGGUPATI NITHISH KUMAR	8	9	6	3
18	20201ECE0024	KASAVAJJALA LAKSHMI SAHITHI	9	1	6	8
19	20201ECE0025	N VINUTHA SREE	1	3	6	2
20	20201ECE0026	MUTTE UNNATI	2	5	6	4
21	20201ECE0027	ALURU HEMANTH ROYAL	3	7	7	1
22	20201ECE0028	YOGESH KONDAPPA	4	9	7	4
23	20201ECE0029	ABHAY SURYA R N	5	1	7	6
24	20201ECE0032	JANAGANI THARUN	6	3	7	3
25	20201ECE0034	SAHANA	7	5	7	6
26	20201ECE0035	CHARAN H R	8	7	8	2
27	20201ECE0036	JYOTHIKA M	9	1	8	9
28	20201ECE0037	J SHYAM DIVAS	1	3	8	4
29	20201ECE0038	CHETHAN KUMAR U	2	5	8	5
30	20201ECE0039	SHARATH KUMAR S	3	7	4	1

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Sl. No:	*Reg No:*	*Name of Student*	L_1	L_2	*C*	*R*
31	20201ECE0040	PALAVARA SANDEEP	4	9	4	2
32	20201ECE0041	SREEJA S NAIR	5	2	4	5
33	20201ECE0042	LIKITH D (CR)	6	4	1	3
34	20201ECE0043	NAMITHA V KOTUR	7	6	4	5
35	20201ECE0044	BOYILLA VENKATA RAGHU VIKAS REDDY	8	8	4	6
36	20201ECE0045	PUTHA VENKATA KARTHIK REDDY	9	2	2	2
37	20201ECE0046	CHILAKALA RADHAKIRAN	1	7	2	6
38	20201ECE0047	CHAKALI BABU KIRAN	2	8	2	5
39	20201ECE0049	NANDAKISHORE S	2	4	3	6
40	20201ECE0050	NEHA.M.JAGADISH	3	6	5	2
41	20201ECE0052	DASARI DAVID PRABHU	4	8	7	4
42	20201ECE0054	N BHARATH REDDY	5	2	9	7
43	20201ECE0056	AANANDALA LAXMINIVAS	6	1	1	9
44	20201ECE0057	POLEPALLI VINAY KUMAR	7	3	2	3
45	20201ECE0058	DILEEP N	8	5	4	5
46	20201ECE0059	KODURU SHIREESHA	9	7	6	1
47	20201ECE0060	T MADHAN MOHAN	1	2	8	2
48	20201ECE0061	DIKSHA KARABASAPPA HALAVAGALI	5	4	2	6
49	20201ECE0062	MACHINA SUDEEP KUMAR	3	1	4	3
50	20201ECE0063	AARYA ANIL KATIWALE	7	3	3	7
51	20201ECE0064	YEDDULA NAVYA	2	6	1	8
52	20211LEC0001	ASHA M	6	2	5	3
53	20211LEC0002	DIGUVINTI GOVARDHAN REDDY	4	3	7	4
54	20211LEC0004	VED PRAKASH SINGH	8	1	2	1
55	20211LEC0005	NAGI REDDY VAMSIDHAR REDDY	2	1	3	2
56	20211LEC0006	SHAIK ABDUL VASEEM BASHA	1	2	4	8
57	20211LEC0007	SIRIPI REDDY HEMANTH REDDY	3	2	7	6
58	20211LEC0008	T SAGAR	6	2	3	4
59	20211LEC0009	RAMYASHREE G	1	8	7	3

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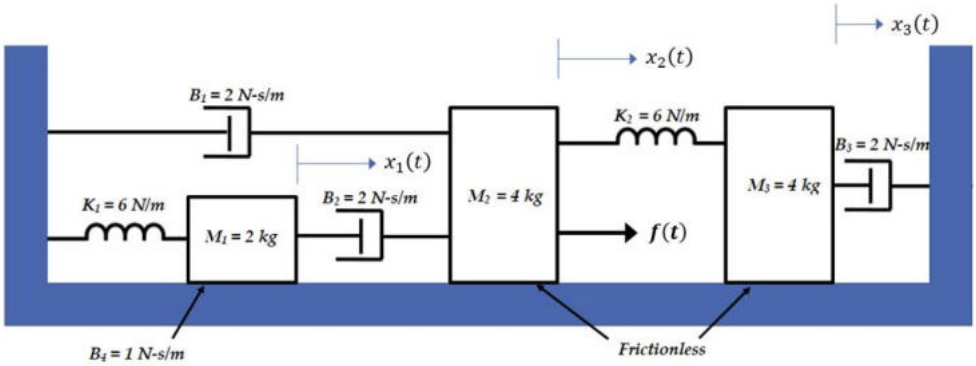
Question 2: For the mechanical system shown below, find the transfer function

Girls find $\frac{X_1(s)}{F(s)}$ and draw the force voltage analogous circuit [Proper analysis]

Boys find $\frac{X_2(s)}{F(s)}$ and draw the force current analogous circuit [Proper analysis]



Extra Credit ☺☺☺ : Simulate the transfer function obtained in MATLAB and hence plot the displacement and velocity of the concerned mass when a unit step is applied

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PRESIDENCY UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ASSIGNMENT 1

20/20

STUDENT DETAILS

7/10/2022

Name: Mutte Unnati

Roll Number: 20201ECE0026

Section: 5ECE1

Branch: Electronics and Communication Engineering

Course: Control Systems

Course Code: ECE3007

Faculty-In charge: Mr. Tony Aby Varkey M Sir

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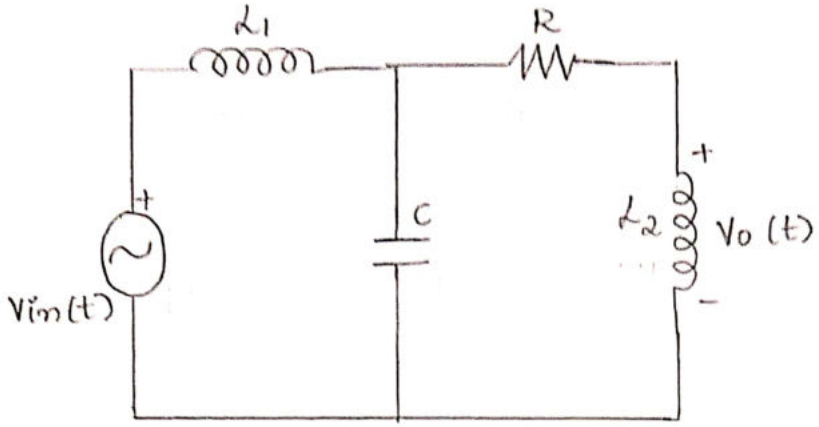
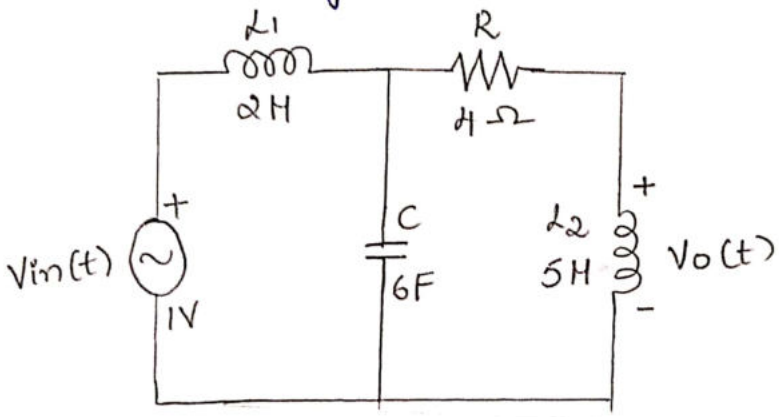
Name:- Mutte Unnati
Roll no:- 20201ECE0026

Question 1:- Consider the circuit shown below



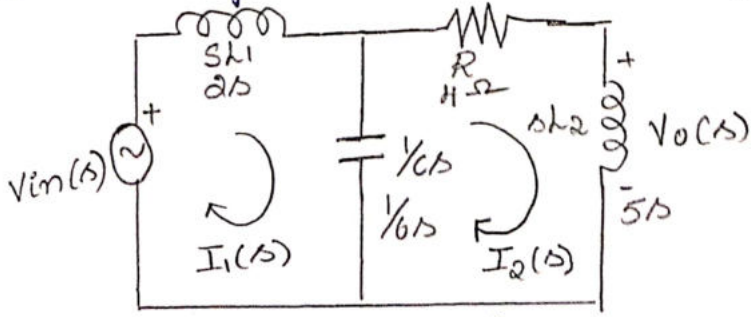
The values of $L_1 = 2H$, $L_2 = 5H$, $C = 6F$, $R = 4\Omega$

ans) Circuit diagram



Transfer function :-

redrawing the circuit in frequency domain



write the mesh equations

mesh 1

$$-V_{in}(s) + 2s\,I_1(s) + \tfrac{1}{6s}(I_1(s) - I_2(s)) = 0$$

$$-V_{in}(s) + 2s\,I_1(s) + \tfrac{1}{6s}I_1(s) - \tfrac{1}{6s}I_2(s) = 0$$

$$(2s + \tfrac{1}{6s})\,I_1(s) - \tfrac{1}{6s}I_2(s) = V_{in}(s)$$

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Roll no:- 20201ECE0026

$$\frac{1}{6s}(I_2(s) - I_1(s)) + 4I_2(s) + 5s(I_2(s)) = 0$$

$$\frac{1}{6s}I_2(s) - \frac{1}{6s}I_1(s) + 4I_2(s) + 5s(I_2(s)) = 0$$

$$\left(4 + 5s + \frac{1}{6s}\right)I_2(s) - \frac{1}{6s}I_1(s) = 0$$

matrix form

$$\begin{bmatrix} 2s + \frac{1}{6s} & -\frac{1}{6s} \\ -\frac{1}{6s} & 4 + 5s + \frac{1}{6s} \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix} = \begin{bmatrix} V_{in}(s) \\ 0 \end{bmatrix}$$

using Cramers rule

$$\Delta = \begin{vmatrix} 2s + \frac{1}{6s} & -\frac{1}{6s} \\ -\frac{1}{6s} & 4 + 5s + \frac{1}{6s} \end{vmatrix}$$

$$= (2s + \tfrac{1}{6s})(4 + 5s + \tfrac{1}{6s}) - \tfrac{1}{36s^2}$$

$$= 8s + \frac{4}{6s} + 10s^2 + \frac{5s}{6s} + \frac{2s}{6s} + \frac{1}{36s^2} - \frac{1}{36s^2}$$

$$= 48s^2 + 4 + 60s^3 + 5s + 2s$$

$$\Delta = 60s^3 + 48s^2 + 7s + 4$$

$$\Delta_2 = \begin{vmatrix} 2s + \frac{1}{6s} & V_{in}(s) \\ -\frac{1}{6s} & 0 \end{vmatrix}$$

$$\Delta_2 = V_{in}(s)\frac{1}{6s}$$

$$I_2(s) = \frac{\Delta_2}{\Delta} = \frac{V_{in}(s)\frac{1}{6s}}{\frac{60s^3 + 48s^2 + 7s + 4}{6s}}$$

$$I_2(s) = \frac{V_{in}(s)}{60s^3 + 48s^2 + 7s + 4}$$

from the circuit

$$V_o(s) = 5s\,I_2(s)$$

$$V_o(s) = \frac{5s\,V_{in}(s)}{60s^3 + 48s^2 + 7s + 4}$$

$$\frac{V_o(s)}{V_{in}(s)} = \frac{5s}{60s^3 + 48s^2 + 7s + 4}$$

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Name:- Mutte Unnati
Roll no:- 20201ECE0026

Matlab code:-

```
clc;
clear;
close all;

diary Circuit1
disp ('NAME: Mutte Unnati')
disp ('ROLL NO: 20201ECE0026')
disp ('SEMESTER AND SECTION: 5ECE1')
Date_Time = datestr (cputime)

num = [0, 0, 5, 0];
den = [60, 48, 7, 1];
H = tf (num, den);
t = 0:0.0001:450;
Vo = step (H, t);
plot (t, Vo, 'linewidth', 2);
grid;
xlabel ('Time ,t(s)');
ylabel ('V_O(t) (V)');
title ('The output voltage');

diary off
```

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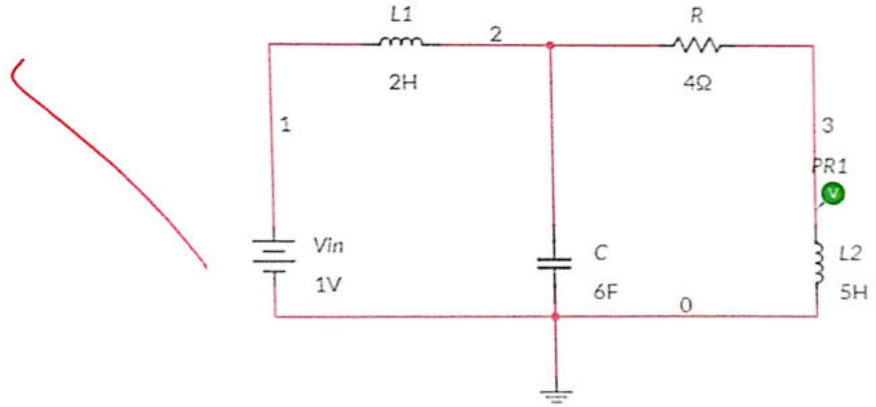
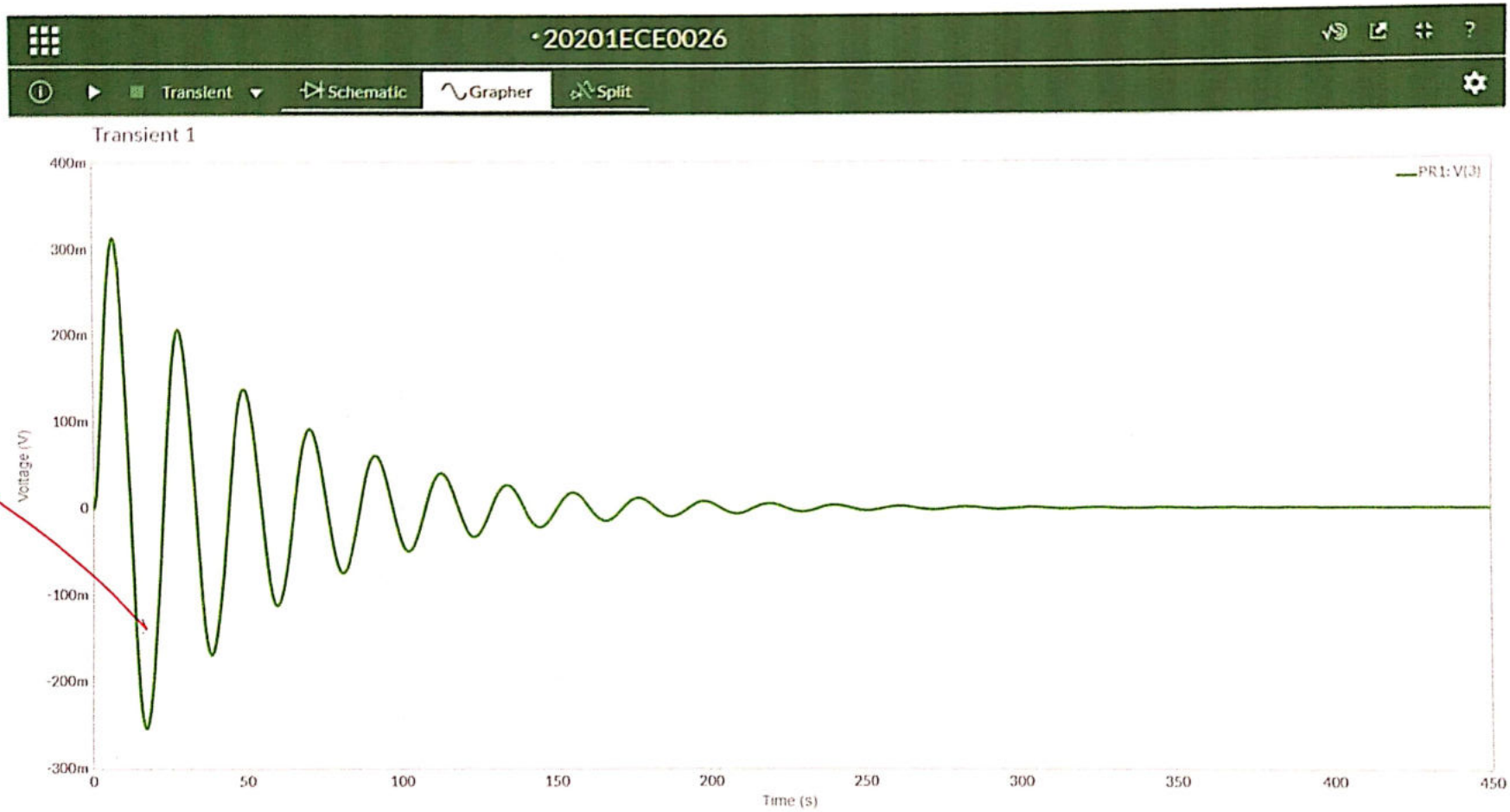
*20201ECE0026

Transient | Schematic | Grapher | Split

Name: Mutte Unnati
Roll number: 20201ECE0026





```
clc;
clear;
close all;

diary Circuit1
disp('NAME: Mutte Unnati')
disp('ROLL NO: 20201ECE0026')
disp('SEMESTER AND SECTION: 5ECE1')
Date_Time = datestr(cputime)

num = [0, 0, 5, 0];
den =[60, 48, 7, 4];
H = tf(num,den);
t= 0:0.0001:450;
vo = step(H, t);
plot(t, vo, 'linewidth', 2);
grid;
xlabel('Time, t(s)');
ylabel('v_o(t)   (V)');
title('The output voltage');

diary off
```

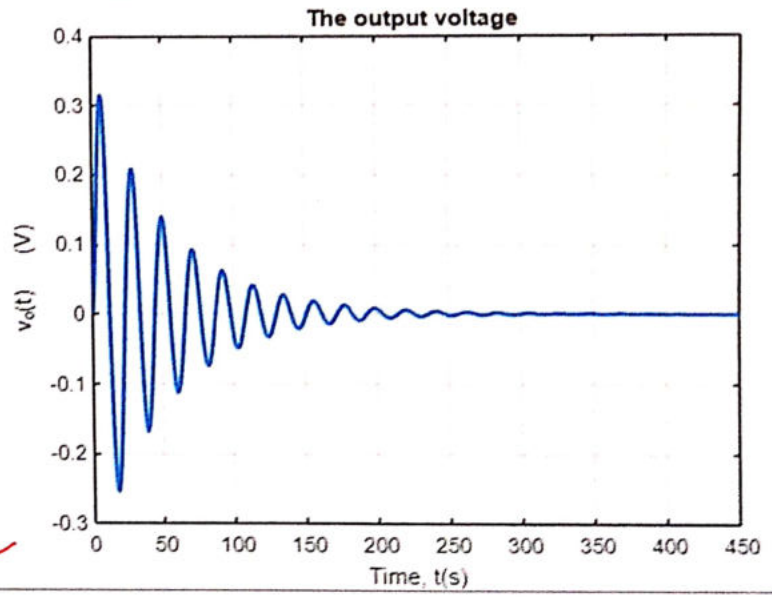


Figure 1

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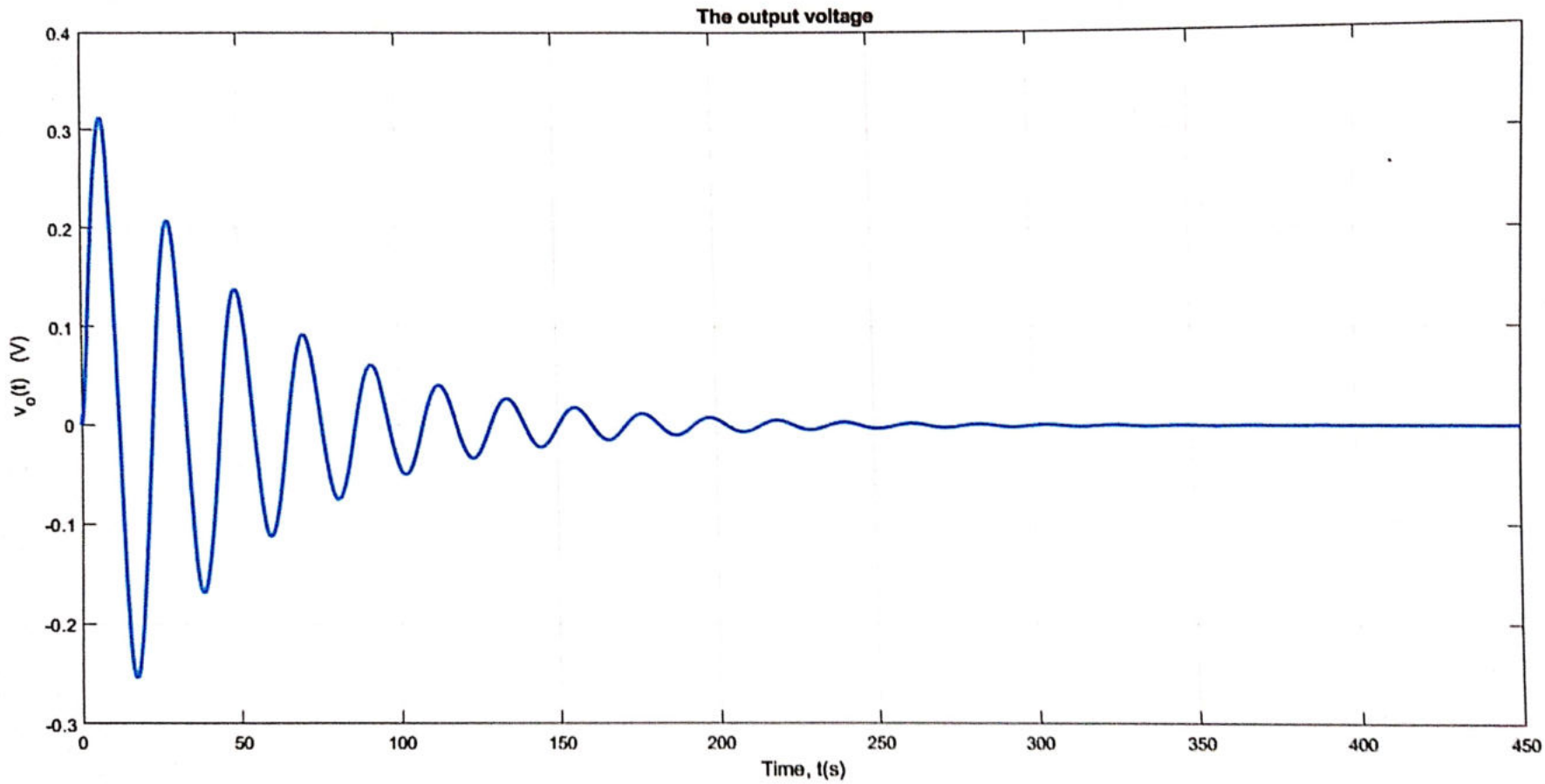

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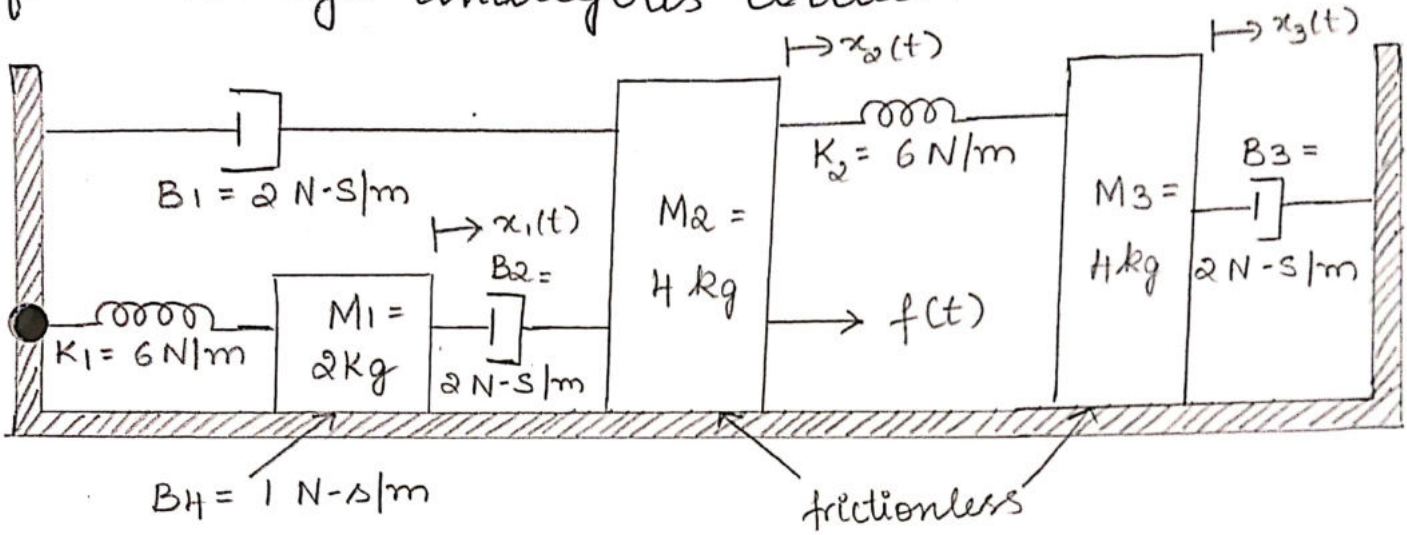
ENG IN 06-

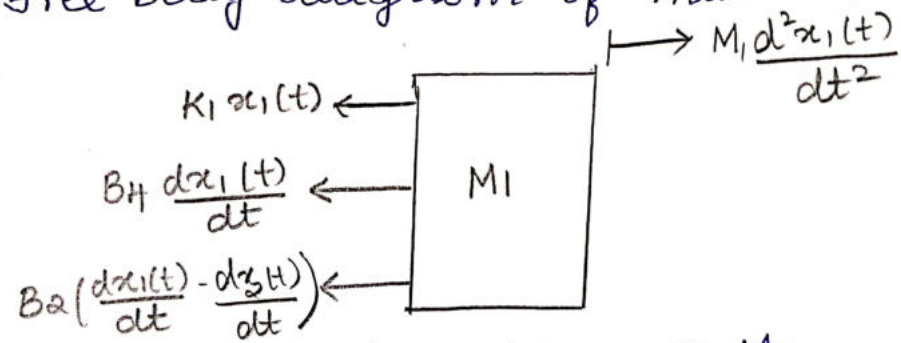
Name:- Mutte Unnati
Roll no:- 20201ECE0026

question 2:-

For the mechanical system shown below, find the transfer function $\frac{X_1(s)}{F(s)}$ and draw the force voltage analogous circuit.



ans) Free body diagram of mass M_1



Differential equation for mass M_1

$$0 - K_1 x_1(t) - B_H \frac{dx_1(t)}{dt} - B_2\left(\frac{dx_2(t)}{dt} - \frac{dx_2(t)}{dt}\right) = M_1 \frac{d^2x_1(t)}{dt^2}$$

$$M_1 \frac{d^2x_1(t)}{dt^2} + B_H \frac{dx_1(t)}{dt} + B_2\left(\frac{dx_1(t)}{dt} - \frac{dx_2(t)}{dt}\right) + K_1 x_1(t) = 0$$

$$2\frac{d^2x_1(t)}{dt^2} + \frac{dx_1(t)}{dt} + \frac{2dx_1(t)}{dt} - \frac{2dx_2(t)}{dt} + 6x_1(t) = 0$$

$$2\frac{d^2x_1(t)}{dt^2} + \frac{3dx_1(t)}{dt} - \frac{2dx_2(t)}{dt} + 6x_1(t) = 0$$

Laplace transform

$$\mathcal{L}\left\{2\frac{d^2x_1(t)}{dt^2} + 3\frac{dx_1(t)}{dt} - 2\frac{dx_2(t)}{dt} + 6x_1(t)\right\} = \mathcal{L}(0)$$

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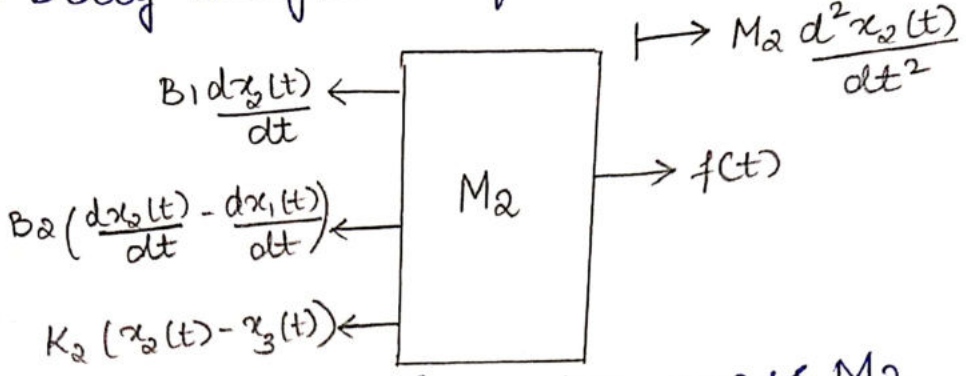
Roll no:- 20201ECE0026

$2s^2X_1(s) + 3sX_1(s) - 2sX_2(s) + 6X_1(s) = 0$

$(2s^2+3s+6)X_1(s) - 2sX_2(s) = 0$

Free body diagram of mass M_2



Differential equation for mass M_2

$$f(t) - B_1\frac{dx_2(t)}{dt} - B_2\left(\frac{dx_2(t)}{dt} - \frac{dx_1(t)}{dt}\right) - K_2(x_2(t) - x_3(t)) = M_2\frac{d^2x_2(t)}{dt^2}$$

$$M_2\frac{d^2x_2(t)}{dt^2} + B_1\frac{dx_2(t)}{dt} + B_2\left(\frac{dx_2(t)}{dt} - \frac{dx_1(t)}{dt}\right) + K_2(x_2(t) - x_3(t)) = f(t)$$

$$4\frac{d^2x_2(t)}{dt^2} + 2\frac{dx_2(t)}{dt} + 2\frac{dx_2(t)}{dt} - 2\frac{dx_1(t)}{dt} + 6x_2(t) - 6x_3(t) = f(t)$$

$$4\frac{d^2x_2(t)}{dt^2} + 4\frac{dx_2(t)}{dt} - 2\frac{dx_1(t)}{dt} + 6x_2(t) - 6x_3(t) = f(t)$$

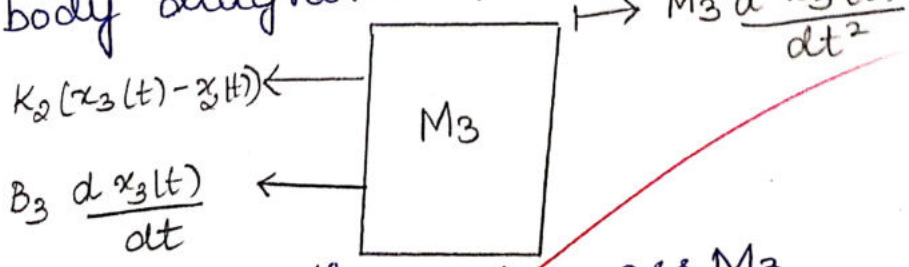
Laplace transform

$$\mathcal{L}\left\{4\frac{d^2x_2(t)}{dt^2} + 4\frac{dx_2(t)}{dt} - 2\frac{dx_1(t)}{dt} + 6x_2(t) - 6x_3(t)\right\} = \mathcal{L}\{f(t)\}$$

$$4s^2X_2(s) + 4sX_2(s) - 2sX_1(s) + 6X_2(s) - 6X_3(s) = F(s)$$

$$(4s^2+4s+6)X_2(s) - 2sX_1(s) - 6X_3(s) = F(s)$$

Free body diagram of mass M_3



Differential equation for mass M_3

$$0 - K_2(x_3(t) - x_2(t)) - B_3\frac{dx_3(t)}{dt} = M_3\frac{d^2x_3(t)}{dt^2}$$

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$$M_3\frac{d^2x_3(t)}{dt^2} + K_2(x_3(t) - x_2(t)) + B_3\frac{dx_3(t)}{dt} = 0$$

$$4\frac{d^2x_3(t)}{dt^2} + 6x_3(t) - 6x_2(t) + 2\frac{dx_3(t)}{dt} = 0$$

Laplace transform

$$\mathcal{L}\left\{4\frac{d^2x_3(t)}{dt^2} + 2\frac{dx_3(t)}{dt} + 6x_3(t) - 6x_2(t)\right\} = \mathcal{L}\{0\}$$

$$4s^2X_3(s) + 2sX_3(s) + 6X_3(s) - 6X_2(s) = 0$$

$$(4s^2+2s+6)X_3(s) - 6X_2(s) = 0$$

Matrix form

$$\begin{bmatrix} 2s^2+3s+6 & -2s & 0 \\ -2s & 4s^2+4s+6 & -6 \\ 0 & -6 & 4s^2+2s+6 \end{bmatrix}\begin{bmatrix} X_1(s) \\ X_2(s) \\ X_3(s) \end{bmatrix} = \begin{bmatrix} 0 \\ F(s) \\ 0 \end{bmatrix}$$

using cramers rule

$$\Delta = \begin{vmatrix} 2s^2+3s+6 & -2s & 0 \\ -2s & 4s^2+4s+6 & -6 \\ 0 & -6 & 4s^2+2s+6 \end{vmatrix}$$

- $(2s^2+3s+6)\left[(4s^2+4s+6)(4s^2+2s+6) - 36\right] + 2s\left[-2(4s^2+2s+6)\right]$

$$= (2s^2+3s+6)\left[16s^4+16s^3+24s^2+8s^3+8s^2+12s+24s^2+24s+36-36\right] + 2s\left[-8s^3-4s^2-12s\right]$$

$$= 32s^6+48s^5+48s^5+96s^4+72s^4+112s^4-16s^4+144s^3+168s^3+72s^3-8s^3+336s^2+108s^2-24s^2+216s$$

$$\Delta = 32s^6+96s^5+264s^4+376s^3+420s^2+216s$$

$$\Delta_1 = \begin{vmatrix} 0 & -2s & 0 \\ F(s) & 4s^2+4s+6 & -6 \\ 0 & -6 & 4s^2+2s+6 \end{vmatrix}$$

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$$\Delta_1 = 2s(4s^2+2s+6)F(s)$$

$$\Delta_1 = (8s^3+4s^2+12s)F(s)$$

$$X_1(s) = \frac{\Delta_1}{\Delta} = \frac{4(2s^2+s+3)F(s)}{4s(8s^5+24s^4+66s^3+94s^2+105s+54)}$$

$$\boxed{\frac{X_1(s)}{F(s)} = \frac{2s^2+s+3}{8s^5+24s^4+94s^2+66s^3+105s+54}}$$

The force-voltage analogous circuit for the given mechanical system

Consider the differential equations of masses M1, M2 and M3

$$M_1\frac{d^2x_1(t)}{dt^2} + B_1\frac{dx_1(t)}{dt} + B_2\left(\frac{dx_1(t)}{dt} - \frac{dx_2(t)}{dt}\right) + K_1x_1(t) = 0$$

$$M_2\frac{d^2x_2(t)}{dt^2} + B_1\frac{dx_2(t)}{dt} + B_2\left(\frac{dx_2(t)}{dt} - \frac{dx_1(t)}{dt}\right) + K_2(x_2(t)-x_3(t)) = f(t)$$

$$M_3\frac{d^2x_3(t)}{dt^2} + K_2(x_3(t)-x_2(t)) + B_3\frac{dx_3(t)}{dt} = 0$$

Rewriting the equations according to force voltage analogy

$$L_1\frac{d^2q_1(t)}{dt^2} + R_1\frac{dq_1(t)}{dt} + R_2\left(\frac{dq_1(t)}{dt} - \frac{dq_2(t)}{dt}\right) + \frac{1}{C_1}q_1(t) = 0$$

$\{f(t)\leftrightarrow V \quad M\leftrightarrow L \quad B\leftrightarrow R \quad K\leftrightarrow 1/C \quad x(t)\leftrightarrow q(t)\}$

$$L_2\frac{d^2q_2(t)}{dt^2} + R_1\frac{dq_2(t)}{dt} + R_2\left(\frac{dq_2(t)}{dt} - \frac{dq_1(t)}{dt}\right) + \frac{1}{C_2}(q_2(t)-q_3(t)) = V$$

$$L_3\frac{d^2q_3(t)}{dt^2} + \frac{1}{C_2}(q_3(t)-q_2(t)) + R_3\frac{dq_3(t)}{dt} = 0$$

Replace $\frac{d}{dt}q(t) = i(t)$ and $q(t) = \int i(t)\,dt$

$$L_1\frac{d}{dt}i_1(t) + R_1i_1(t) + R_2(i_1(t)-i_2(t)) + \frac{1}{C_1}\int i_1(t)dt = 0$$

$$L_2\frac{d}{dt}i_2(t) + R_1i_2(t) + R_2(i_2(t)-i_1(t)) + \frac{1}{C_2}\left(\int i_2(t)dt - \int i_1(t)dt\right) = V$$

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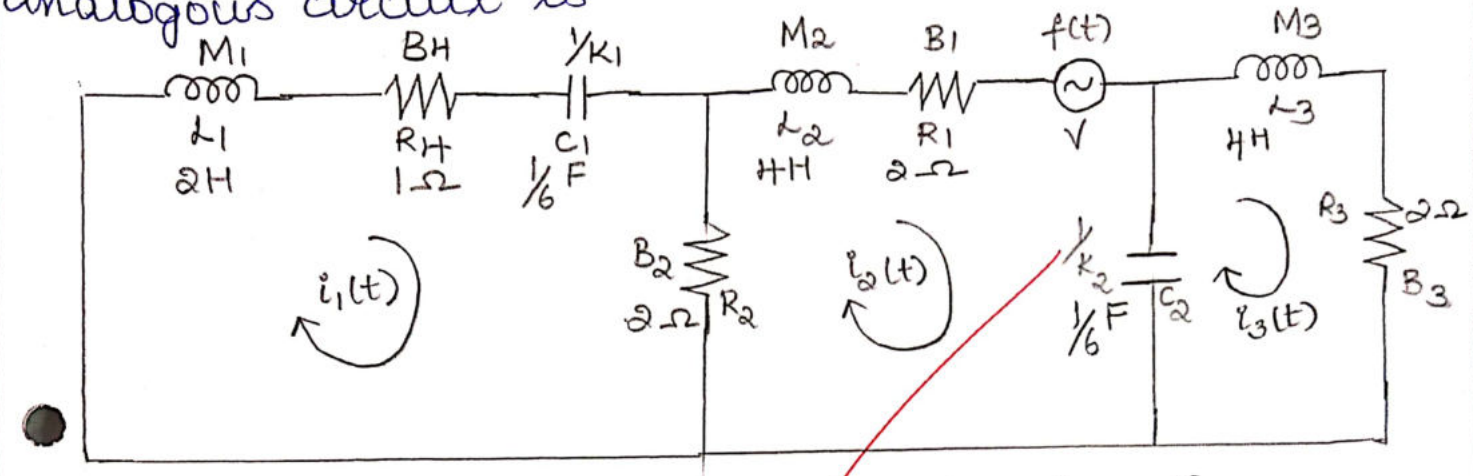
Roll no:- 20201ECE0026

$$M_3 \frac{d}{dt} i_3(t) + \frac{1}{C_2}\left(\int i_3(t)\,dt - \int i_2(t)\,dt\right) + R_3 i_3(t) = 0$$

There are two mesh equations, the force voltage analogous circuit is



Matlab code for simulation of transfer function

```
clc;
clear;
close all;
num = [2, 1, 3];
den = [8, 2H, 66, 94, 105, 5H];
H = tf(num, den);
t = 0:0.0001:80;
Vo = step(H,t);
plot(t, Vo, 'linewidth', 2);
grid;
xlabel('Time t(s)');
ylabel('V_0(t) (V)');
title('The output voltage');
```

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MATLAB

matlab.mathworks.com

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Save As Show Code Helvetica 2 Line Color Title X-Label Y-Label Legend Colorbar Grid Remove G... X-Grid Y-Grid Text Arrow Format

FILE TEXT STYLE LINE STYLE LABELS AND ANNOTATIONS FORMAT

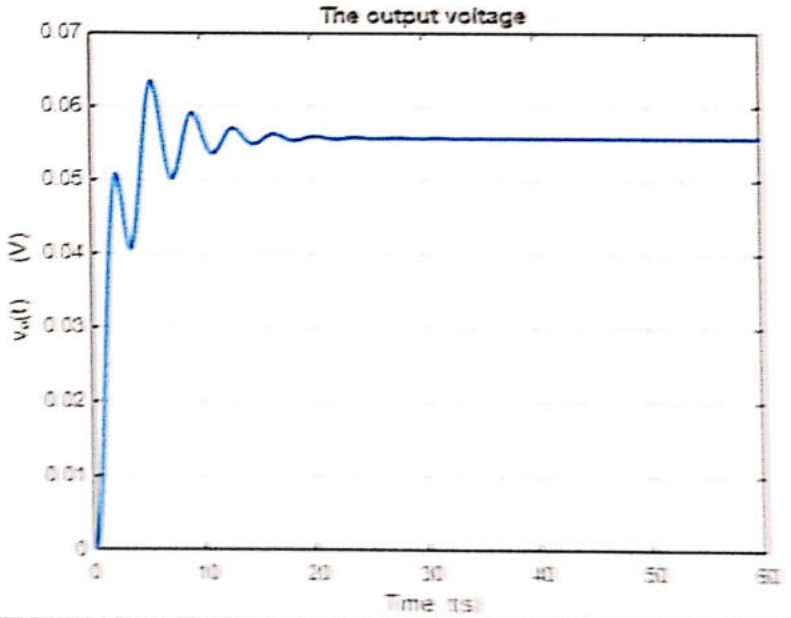
/ > MATLAB Drive >

CURRENT FOLDER WORKSPACE

U20201ece0026_2.m

```
clc;
clear;
close all;
num = [2, 1, 3];
den =[8, 24, 66, 94, 105, 54];
H = tf(num,den);
t= 0:0.0001:60;
vo = step(H, t);
plot(t, vo, 'linewidth', 2);
grid;
xlabel('Time, t(s)');
ylabel('v_o(t)    (V)');
title('The output voltage');
```

Figure 1



COMMAND WINDOW

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Course Code: ECE3009	**Course Title: Transmission Lines and Waveguides** **Type of Course: Program Core & Theory only**	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**The knowledge of vector algebra, basics of electrical engineering, network theory and MATLAB-SIMULINK software tool**				
Anti-requisites	**NIL**				
Course Description	**The course focuses on various types of transmission lines used in daily life. The course includes stub impedance matching, transmission and reception of high frequency waves through co-axial cable and waveguide. This course lays a foundation for many communication related courses like satellite communication, mobile communication, analog and digital communication etc.**				
Course Objective	**The objective of the course is to familiarize the learners with the concepts of Transmission Lines and Waveguides and attain the SKILL DEVELOPMENT through PROBLEM SOLVING.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** 1. Discuss the working of transmission lines such as co-axial cable and associated parameters 2.Compute the calculations pertaining to stub impedance and its parameters 3. Describe the working of waveguide such as rectangular waveguide and associated parameters				
Course Content:					
Module 1	**Transmission Lines and its parameters**	Assignment	Simulation task (transmission lines and its parameters)	**13 Session**	
Topics: Introduction to Transmission lines, transmission line parameters calculation for co-axial cable, Transmission line equations, Concept and numerical on input impedance,Reflection coefficient, VSWR, characteristic impedance, open and short circuited lines.					
Module 2	**Stub impedance matching**	Assignment	Simulation task (stub impedance matching parameters)	**13 Session**	
Topics: Introduction to stub impedance matching, single stub impedance matching and numerical, double stub impedance matchingand numerical, Smith chart fundamentals , construction of Smith chart, use of Smith chart to solve stub impedance matching problems, Some applications of transmission lines					
Module 3	**Waveguide**	Assignment	Simulation task(parameters calculation in waveguide)	**13 Session**	
Topics: Introduction, properties and characteristics of waveguides, Applications of Waveguides, General approach to solve field inside waveguide,TM wave in rectangular waveguide, various TM modes, waveguide as a high pass filter, Power transmission and attenuation, TE wave in rectangular waveguide, various TE modes, excitation of waveguides, waveguide terminations, introduction to waveguide resonators					
List of Laboratory Tasks: Nil					
Targeted Application & Tools that can be used: **Application Area:**Telecommunication, Satellite communication, low and high frequency magnetic field transmission, Wireless technology, Optical communication. **Professionally Used Hardware/Software:** Arduino/Raspberry Pi , MATLAB/SIMULINK/Arduino/Python					

Text Book(s)

1. K. Giridhar, "Transmission Lines and Wave Guides", Pooja Publications, India, Fourth Edition.

Reference Book(s):

1. Pramanik, Ashutosh, "Electromagnetism – Theory and Applications", Prentice-Hall of India Private Limited, Second Edition.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-013-electromagnetics-and-applications-fall-2005/lecture-notes/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-776-high-speed-communication-circuits-spring-2005/lecture-notes/
3. https://presiuniv.knimbus.com/user#/home

E-content:

1. H. He, B. Li and Y. Sun, "The study of different transmission lines in high speed optical module," 2014 15th International Conference on Electronic Packaging Technology, 2014, pp. 1052-1055, doi: 10.1109/ICEPT.2014.6922826. https://ieeexplore.ieee.org/document/6922826
2. F. Olyslager, "Properties of and generalized full-wave transmission line models for hybrid (Bi)(an)isotropic waveguides," in IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 11, pp. 2064-2075, Nov. 1996, doi: 10.1109/22.543964. https://ieeexplore.ieee.org/document/543964
3. W. J. Getsinger, "An introduction to microwave transmission lines," [1992] Proceedings of the 35th Midwest Symposium on Circuits and Systems, 1992, pp. 1016-1019 vol.2, doi: 10.1109/MWSCAS.1992.271122. https://ieeexplore.ieee.org/document/271122
4. F. Distler, J. Schür and M. Vossiek, "In-depth characterization of a dielectric waveguide for mmW transmission line applications," 2018 IEEE 22nd Workshop on Signal and Power Integrity (SPI), 2018, pp. 1-4, doi: 10.1109/SaPIW.2018.8401671. https://ieeexplore.ieee.org/document/8401671

Topics relevant to "SKILL DEVELOPMENT": Transmission line parameters, Reflection coefficient, VSWR, Impedance Matching, Smith Chart, Waveguides for **Skill Development** through **Problem Solving** techniques. This is attained through assessment component mentioned in course handout.

Topics related to development of "FOUNDATION SKILLS": Fundamentals of various transmission lines and associated parameters

Topics related to development of "ENVIRONMENT AND SUSTAINABILITY": High frequency waves

Catalogue prepared by	Dr. Rakesh Chowdhury
Recommended by the Board of Studies on	BOS Meeting NO: 15th, Dated BOS 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/22

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PRESIDENCY UNIVERSITY Registrar BANGALORE

SCHOOL: Engineering **DEPT.:** ECE **DATE OF ISSUE:** 27/08/2022

ACA-2 [2022] COURSE HANDOUT

NAME OF THE PROGRAM	**:** B. Tech (ECE)
P.R.C.APPROVAL REF.	**:** PU/AC-18.4/ECE15/ECE/2022-24
SEMESTER/YEAR	**:** 5th Semester/ 3rd Year
COURSE TITLE & CODE	**:** Transmission Lines and Waveguides &ECE3009
COURSE CREDIT STRUCTURE	**:** 3-0-0-3
CONTACT HOURS	**:** 45
COURSE INSTRUCTOR	**:** Sreenivasappa

PROGRAM OUTCOMES:

Graduates of the B. Tech. Program in Electronics and Communication Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES: The knowledge of vector algebra, basics of electrical engineering, network theory and MATLAB-SIMULINK software tool.

COURSE DESCRIPTION: The course focuses on various types of transmission lines used in daily life. The course includes stub impedance matching, transmission and reception of high frequency waves through co-axial cable and waveguide. This course lays a foundation for many communication related courses like satellite communication, mobile communication, analog and digital communication etc.

COURSE OBJECTIVES:

The objective of the course is to familiarize the learners with the concepts of Transmission Lines and Waveguides and attain the SKILL DEVELOPMENT through PROBLEM SOLVING.

COURSE OUTCOMES:

On successful completion of the course the students shall be able to:

CO1: Explain the working of transmission lines such as co-axial cable and associated parameters

CO2: Summarize the calculations pertaining to stub impedance and its parameters

CO3: Describe the working of waveguide such as rectangular waveguide and associated parameters

MAPPING OF C.O. WITH P.O.

[H-HIGH, M- MODERATE, L-LOW]

PO / CO	1	2	3	7	12
1	H	L	M		
2	H			M	M
3	H	M	H	H	

COURSE CONTENT (SYLLABUS):

Module: 1:Transmission Lines and its parameters:

Introduction to Transmission lines, transmission line parameters calculation for co-axial cable, Transmission line equations, Concept and numerical on input impedance, Reflection coefficient, VSWR, characteristic impedance, open and short circuited lines.
[13 hours] [Blooms' level selected: Knowledge]

Module: 2: Stub impedance matching:

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Introduction to stub impedance matching, single stub impedance matching and numerical, double stub impedance matching and numerical, Smith chart fundamentals , construction of Smith chart, use of Smith chart to solve stub impedance matching problems, Some applications of transmission lines
[13 hours] [Blooms' level selected: Application]

Module 3:Waveguides:

Introduction, properties and characteristics of waveguides, Applications of Waveguides, General approach to solve field inside waveguide, TM wave in rectangular waveguide, various TM modes, waveguide as a high pass filter, Power transmission and attenuation, TE wave in rectangular waveguide, various TE modes, excitation of waveguides, waveguide terminations, introduction to waveguide resonators .

[12 hours] [Blooms' level selected: Comprehension]

SKILL SETS TO BE DEVLOPED:

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. **Ability to interpret events and results.**
4. Ability to work as a leader and as a member of a team.
5. Assess errors in systems/processes/programs/computations and eliminate them.
6. **Observe and measure physical phenomena.**
7. **Write reports.**
8. **Select suitable equipment, instrument, materials & software**
9. Locate faults in system/Processes/software.
10. **Manipulative skills for setting and handling systems/Process/Issues**
11. **The ability to follow standard /Legal procedures**.
12. An awareness of the Professional Ethics.
13. Need to observe safety/General precautions.
14. **To judge magnitudes/Results/issues without actual measurement/actual contacts**

DELIVERY PROCEDURE (PEDAGOGY): All the Topics will be covered through Offline mode in Classroom. Assignment projects based on course contents will be given to the students.

Self-Learning topics: Calculations of R, L, G, C for a given co-axial cable, Impedance matching using lumped elements, TEM waveguide

Experiential Learning:Transmission line parameters measurement for 10m Flexible RG174 Coaxial Cable

REFERENCE MATERIALS: Textbooks, reference books, any other resources, like webpages.

(I) Text Book(s):

1. K. Giridhar, "Transmission Lines and Wave Guides", Pooja Publications, India, Fourth Edition.

(II) Reference book(s):

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1. Pramanik, Ashutosh, “Electromagnetism – Theory and Applications”, Prentice-Hall of India Private Limited, Second Edition.

(III) Class Notes/Online Resources

4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-013-electromagnetics-and-applications-fall-2005/lecture-notes/
5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-776-high-speed-communication-circuits-spring-2005/lecture-notes/

(IV) E-contents:

5. H. He, B. Li and Y. Sun, "The study of different transmission lines in high speed optical module," 2014 15th International Conference on Electronic Packaging Technology, 2014, pp. 1052-1055, doi: 10.1109/ICEPT.2014.6922826. https://ieeexplore.ieee.org/document/6922826
6. F. Olyslager, "Properties of and generalized full-wave transmission line models for hybrid (Bi)(an)isotropic waveguides," in IEEE Transactions on Microwave Theory and Techniques, vol. 44, no. 11, pp. 2064-2075, Nov. 1996, doi: 10.1109/22.543964. https://ieeexplore.ieee.org/document/543964
7. W. J. Getsinger, "An introduction to microwave transmission lines," [1992] Proceedings of the 35th Midwest Symposium on Circuits and Systems, 1992, pp. 1016-1019 vol.2, doi: 10.1109/MWSCAS.1992.271122. https://ieeexplore.ieee.org/document/271122
8. F. Distler, J. Schür and M. Vossiek, "In-depth characterization of a dielectric waveguide for mmW transmission line applications," 2018 IEEE 22nd Workshop on Signal and Power Integrity (SPI), 2018, pp. 1-4, doi: 10.1109/SaPIW.2018.8401671. https://ieeexplore.ieee.org/document/8401671

(V) GUIDELINES TO STUDENTS:

- The students are advised to be very much regular to the classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Microsoft teams on a regular basis to study the supporting materials shared by the course instructors.
- This course deals with the software development practices which and Embedded Developer has to adopt. The course if for LEARNING and being able to work in the domains identified here, and not just learning by rote and reproducing in exam. You need to understand how networking works and design networks, program for protocols and so on.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.

(VI) Presidency University Library Link:https://presiuniv.knimbus.com/user#/home

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COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
1.	Program Integration			01
2.	Course Integration			01
3.	Module : 01			13
4.	Module 01 revision			01
5.	Assignment project			---
6.	Module : 02			13
7.	Module 02 revision			01
8.	Mid Term Examination			NA
9.	Mid Term Paper Discussion			01
10.	Module:03			12
11.	Module 03 revision			02
12.	Assignment project			---
13.	End Term Examination			
			TOTAL	45

SCHEDULE OF INSTRUCTION

Sl. No	Session no/Date*	Lesson Title	Topics	CO. NO	Delivery Mode	Reference
1.	L1		Program Integration			
2.	L2		Course Integration			
3.	L3	Introduction to	Introduction to Transmission lines	1	Board/PPT	T1 Ch 1

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4.	L4	Transmission lines	Transmission line general solution	1	Board/PPT	T1Ch 1
5.	L5	Types of transmission lines	Lossless transmission line	1	Board/PPT	T1Ch 1
6.	L6		Lossy transmission lines	1	Board/PPT	T1Ch 1
7.	L7		Distortionlesstransmission line	1	Board/PPT	T1Ch 1
8.	L8	Parameters of transmission lines	reflection factor, reflection loss	1	Board/PPT	T1Ch 1
9.	L9		insertion loss,	1	Board/PPT	T1Ch 1
10.	L10		VSWR		Board/PPT	T1Ch 1
11.	L11		Numerical on input impedance		Board/PPT	T1Ch 1
12.	L12		Open circuited lines		Board/PPT	T1Ch 1
13.	L13		short circuited lines		Board/PPT	T1Ch 1
14.	L14		Numerical		Board/PPT	T1Ch 1
15.	L15		Revision	1		
	Module 1 Concluded					
			Module 2			
16.	L16	Stub Impedance matching	Introductionto Stub Impedance matching	2	Board/PPT	T1Ch 2
17.	L17	Introduction to Smith Chart	Smith chart construction constant resistance circle	2	Board/PPT	T1 Ch 2
18.	L18		Equations pertaining to constant resistance circle	2	Board/PPT	T1 Ch 2
19.	L19		Constant reactance circle	2	Board/PPT	T1 Ch 2
20.	L20		Equations pertaining to constant reactance circle	2	Board/PPT	T1 Ch 2
21.	L21	Smith Chart for Impedance Matching	Impedance matching with reactive elements	2	Board/PPT	T1 Ch 2
22.	L22		Numerical	2	Board/PPT	T1 Ch 2
23.	L23	Smith Chart for Single Stub	Single stub matching	2	Board/PPT	T1 Ch 2
24.	L24		Numerical	2	Board/PPT	T1 Ch 2
25.	L25	Smith Chart for Double Stub	Double stub matching		Board/PPT	T1 Ch 2
26.	L26		Numerical		Board/PPT	T1 Ch 2
27.	L27	Smith Chart Applications	Applications of Smith chart		Board/PPT	T1 Ch 2
28.	L28		Parameters of Smith chart		Board/PPT	T1 Ch 2
			Assignment Project			
29.	L29		Revision	2		
			Module 2 Concluded			
30.	L30		Mid Term Paper discussion			
			Module 3			
31.	L31	Introduction	Introduction to waveguide	3	Board/PPT	T1Ch 4
32.	L32	Properties	properties and characteristics of waveguides,	3	Board/PPT	T1Ch 4
33.	L33	Application of Maxwell's equation	Application of Maxwell's equation to the rectangular waveguide	3	Board/PPT	T1Ch 4
34.	L34	Rectangular waveguide	TM wave in rectangular waveguide	3	Board/PPT	T1Ch 4
35.	L35		various TM modes	3	Board/PPT	T1Ch 4

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36.	L36		Waveguide as high pass filter	3	Board/PPT	T1Ch 4
37.	L37		TE wave in rectangular waveguide		Board/PPT	T1Ch 4
38.	L38		various TE modes		Board/PPT	T1Ch 4
39.	L39		Numerical		Board/PPT	T1Ch 4
40.	L40		Excitation of waveguide		Board/PPT	T1Ch 4
41.	L41		Waveguide terminations		Board/PPT	T1Ch 4
42.	L42		Numerical		Board/PPT	T1Ch 4
43.	L43		Numerical		Board/PPT	T1Ch 4
44.	L44		Revision of Module-3		Board/PPT	T1Ch 4
45.	L45		Revision of all modules		Board/PPT	T1Ch 4

* These dates are only indicative - applicable to one section handled by subject IC. Dates will vary from section to section.

Topics relevant to "SKILL DEVELOPMENT": Transmission line parameters, Reflection coefficient, VSWR, Impedance Matching, Smith Chart, Waveguides for **Skill Development** through **Problem Solving** techniques. This is attained through the **Assignment** as mentioned in the assessment component.

ASSESSMENT SCHEDULE:

Sl.no	Assessment type	Contents	Course outcome Number	Duration In Minutes	Marks	weightage	Venue, DATE &TIME
1	Assignement	Module-1 and 2	CO1, CO2		30	15%	
2	Mid Term Examination	Module-1 and 2	CO1, CO2	90 minutes	60	30%	
3	Assignment Review of digital / e-resources from Pres. Univ. link given in the References Section - (Mandatory to submit screenshot accessing digital resource. Otherwise it will not be evaluated)	https://ieeexplore.ieee.org/document/6922826 https://ieeexplore.ieee.org/document/543964 ://ieeexplore.ieee.org/document/271122	CO 2 and CO 3	Library visit at least for 2hours	10	5%	Will be announced one week prior to submission-
4	End Term Final Examination	Module-1,2,3	CO1-CO3	3 hrs	100	50%	

COURSE CLEARANCE CRITERIA: A minimum of 75% attendance is required to attend the end term exam. Make-up policy will be only as per academic regulation. There will be no make-up for ASSIGNMENT and QUIZ

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS: It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS:

SL	QUESTION	MARKS	CO NO	BLOOM'S LEVEL

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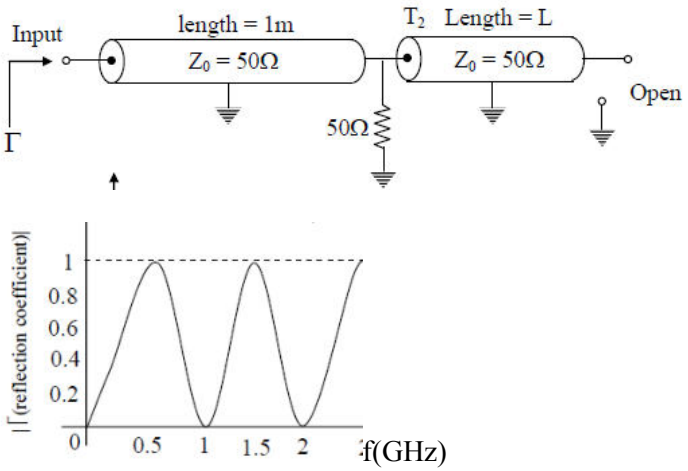
NO				
1	A co-axial lossless transmission lines T1 and T2 as shown in figure. If the phase velocity of the signal shown in the plot is 1.5 X 10^8 m/s. How do you find the length of T2 transmission line? 	06	1	Knowledge
2	Transmission lines enable the transfer of electrical signals by a pair of conducting wires that are separated from each other by a dielectric medium which is usually air. The parameters of the transmission line are distributed over all its length. Identify the parameters of a transmission line.	05	1	Knowledge
3	The key parameter in stub matching is the normalized admittance at a point on the transmission line. A transmission line of characteristic impedance 50Ωis terminated in a load of impedance of 60-j80Ω. It is matched using a short circuited stub of length 'l' located at a distance 'd' from the load. The wavelength of the operation is 1m. Determine d and l using the Smith chart.	10	2	Application
4	Waveguide is a hollow metallic tube to transmit a wave from one point to the other. Standard air-filled rectangular waveguides of dimension a = 2.29 cm and b = 1.02 cm are designed for radar application. It is desired that these waveguides operate only in the dominant TE10 mode but not higher than 95% of the next cutoff frequency. How do you find the range of the allowable operating frequency f	08	3	Comprehension
5	The cutoff frequency of TE01 mode of an air filled rectangular waveguide having inner dimensions a cm x b cm (a>b) is twice that of the dominant TE10 mode. When the waveguide is operated at a frequency which is 25% higher than the cutoff frequency of the dominant mode, the guide wavelength is found to be 4cm. How do you find the value of b in cm.	10	3	Comprehension

Target set for course Outcome attainment:

Sl. NO	CO NO.	Course Outcomes	Target set for attainment in percentage

1.	CO1	Explain the working of transmission lines such as co-axial cable and associated parameters	60%
2.	CO2	Summarize the calculations pertaining to stub impedance and its parameters	50%
3.	CO3	Describe the working of waveguide such as rectangular waveguide and associated parameters	45%

Signature of the course Instructor:

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
1	Midterm Examination			
3	End term Examination			
4	Assignment Project	Before the submission of assessment marks		

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment & Measures to enhance the attainment
01	CO1	Explain the working of transmission lines such as co-axial cable and associated parameters	60%		
02	CO2	Summarize the calculations pertaining to stub impedance and	50%		

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		its parameters			
03	CO3	Describe the working of waveguide such as rectangular waveguide and associated parameters	45%		

Name and signature of the Faculty member:

D.A.C. observation and approval:

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

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PRESIDENCY UNIVERSITY
Private University Estd. in Karnataka State by Act No. 41 of 2013

SCHOOL of ENGINEERING
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Year: 2022-2023 (ODD) **Semester: 5** **Section: 3**

Course Title	**:** TRANSMISSION LINES AND WAVEGUIDES
Course Code	**:** ECE3009
Type of Skill	**:** Skill Development
Type of Activity	**:** Problem Solving
Instructor in Charge	**: Dr. SREENIVASAPPA**
Instructor for Section	**: Mrs Srilakshmi K H**
Details about the activity	**:** Students were asked to submit assignment

Assignment

1. The open-circuit and short-circuit impedances measured at the input terminals of a very low-loss transmission line of length 1.5 m, which is less than a quarter wavelength, are respectively $-j54.6\ \Omega$ and $+j103\ \Omega$.
(i) Find the Z_0 and γ of the line.
(ii) Without changing the operating frequency, find the input impedance of a short-circuited line that is twice the given length.
(iii) How long should the short- circuited line be in order for it to appear as an open-circuit at the input terminals?

2. A $600\ \Omega$ transmission line is $150\ m$ long, operates at $400\ KHz$ with $\alpha = 2.4 * 10^{-2}$ Np/m and $\beta = 0.0212$ rad/m, and supplies power to a load of impedance $Z_R = 424.3\angle 45^\circ\ \Omega$. Find the length of line in wavelengths, Γ_R, Γ_S and Z_S. For a received voltage $\hat{V}_R = 50\angle 0^\circ\ V$, find V_S,at a position on the line where the voltage is a maximum, and the value of $\hat{V}_{max}$.

3. A load $Z_L = 100 + j50\ \Omega$ is connected across a transmission line with $Z_0 = 50\ \Omega$ and $l = 0.4\lambda$. At the generator end, $d = 1$ $Z_S = 100\ \Omega$. What are the input impedance Z_{in} and admittance Y_{in} of the line, including the shunt connected element?

4. A long transmission line has a characteristic impedance Z_0 and is terminated with an impedance Z_L.
(i) Derive an expression for the input impedance Z_{in} in terms of Z_L, Z_0 and Z_{OC} where Z_{OC} is the open-circuited impedance.
(ii) Using the derived result, calculate Z_{in} if $Z_0 = 75\ \Omega$, $Z_L = 100\angle 45^\circ$ and $Z_{OC} = 100\angle -45^\circ$

5. A transmission line of length l has resistance, inductance and leakage conductance per unit length R, L and G and negligible capacitance. It is short-circuited at both ends and at time $t = 0$ a voltage distribution $V = V_0 \sin \frac{\pi x}{l}$ is set up on it. Calculate the subsequent variation in voltage.
(Hint: Assume the voltage to be in the form $V = V_0 \sin \frac{\pi x}{l}\ e^{-\gamma t}$. Find the expression for γ)

6. For a transmission line of $Z_0 = 75\ \Omega$ and length $l = 0.1\lambda$, find the input impedance if the load end is
(i) short-circuited
(ii) open-circuited
In both the cases you must solve using Smith chart and verify analytically.

7. A load of $100 + j150\ \Omega$ connected to a $75\ \Omega$ lossless line. Using a Smith chart, find the following

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- (i) Γ
- (ii) $VSWR$
- (iii) The load admittance Y_L
- (iv) Z_{in} at 0.4λ from the load
- (v) The locations of V_{max} and V_{min} with respect to the load if the line is 0.6λ long
- (vi) Z_{in} at the generator.

8. With an unknown load connected to a slotted air line (a type of transmission line), $VSWR = 2$ is recorded by a VSWR meter and minima are found at $11\,\text{cm}$, $19\,\text{cm}$, ..., on the scale. When the load is replaced by a short circuit, the minima are at $16\,\text{cm}$, $24\,\text{cm}$, ..., . If $Z_0 = 50\ \Omega$, calculate λ, f, and Z_L.

9. Consider a $75\ \Omega$ T_X line terminated in a load. If an open-circuited stub of length 0.15λ and characteristic impedance $100\ \Omega$ is connected at AB (as shown in the figure 1) such that it is located at a distance of 0.30λ from Z_L such that the line is matched, then determine Z_L. Assume that the phase-velocities in the line and the stub are the same and both lines are lossless.

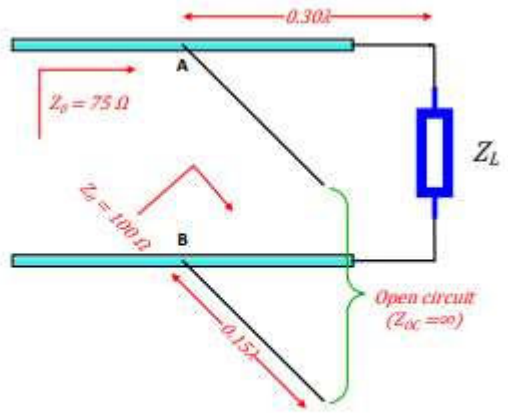

Figure 1: Open-circuited single stub (Q. No. 9)

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10. A 75Ω -line is terminated in a load Z_L . The maximum and minimum currents on the line are $0.2\,A$ and $0.08\,A$. If the nearest voltage minimum is at a distance of 0.15λ from the load, find the following

(i) $VSWR$ and Γ

(ii) Load impedance Z_L

(iii) Nearest distance to the load at which a voltage maximum occurs.

11. An air-filled rectangular waveguide of sides $a \times b$ ($a = 6\,\text{cm}$ and $b = 3\,\text{cm}$). Given that

$$H_z = \cos\frac{\pi y}{b}\ \sin\ 2\pi * 10^{10}t - \beta z$$

determine the mode of operation, and then calculate the phase constant, the wave impedance of this mode and the average power flow in the waveguide.

12. An air-filled rectangular waveguide of sides $a \times b$ is closed at one end by a perfectly conducting plate so that it is short-circuited and is excited at the fundamental mode TE_{10}. Find the resultant electromagnetic field in the waveguid

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ASSIGNMENT - 2

NAME : CHASHMITHA . B

ROLL NO : 20201ECE0145

SECTION : ~~5~~ECE - 3

COURSE : TRANSMISSION LINE AND WAVEGUIDES

27/5

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ASSIGNMENT - 2

01. $Z_{OC} = -j54.6\,\Omega$

$Z_{SC} = j103\,\Omega$

$L = 1.5\,m$

i. $Z_0 = \sqrt{Z_{OC} \cdot Z_{SC}}$

$= \sqrt{j(54.6)(j108)} = 75(1)$

$\gamma = \frac{1}{L} \tan^{-1} h \left[\sqrt{\frac{Z_{SC}}{Z_{OC}}} \right] = \frac{1}{1.5} \tanh^{-1}(-1.37)$

ii. $\beta = \frac{2\pi}{\lambda}$

$\lambda = 4 \times 1.5 = 6$

$\beta = \frac{2\pi}{6} = \frac{\pi}{3}$ rad/m

$\gamma = \alpha + j\beta$

$= 0 + j\left(\frac{\pi}{3}\right)$

$Z_{in} = -j\, Z_0 \times \tanh(j\gamma L)$

$= -j\, Z_0 \tanh(j(\pi/3)\, 3)$

$= Z_0 \tan(\pi)$

$Z_{in} = 0$

2. (i) Length of the line

$\lambda = \frac{2\pi}{\beta}$, $\beta = 0.0212$ rad/m

$\lambda = \frac{2\pi}{0.0212} = 297.03m$

$L = \frac{150}{297.03} = 0.505$

ii. Reflection coefficient

$\Gamma_R = \frac{[Z_R - Z_0]}{[Z_R + Z_0]}$

$Z_0 = 600\,\Omega$

$\Gamma_R = \frac{[424.3 \angle 45^\circ - 600]}{[424.3 \angle 45^\circ + 600\,\Omega]}$

$\Gamma_R = -0.171 \angle 45^\circ$

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5. The wave equation for a lossy Transmission

$$\frac{d^2V}{dx^2} = \left(\frac{R}{L}\right)\frac{dV}{dt} + \left(\frac{G}{C}\right)V$$

$V(0,t) = 0$

$V(l,t) = 0$

find V by substituting $V = V_0 \sin\left(\frac{\pi x}{l}\right)e^{-\gamma t}$ into wave equation

differentiate V w.r.to x

$$\frac{d^2V}{dx^2} = -\left(\frac{+\pi^2}{l^2}\right) V_0 \sin\left(\frac{\pi x}{l}\right)e^{-\gamma t}$$

diff V w.r.to x

$$\frac{dV}{dt} = -V_0\,\gamma \sin\left(\frac{\pi x}{l}\right)e^{-\gamma t}$$

Substitute in wave equation

$$\left(\frac{-\pi^2}{l^2}\right)V_0 \sin\left(\frac{\pi x}{l}\right)e^{-\gamma t} = \left(\frac{R}{L}\right)-V_0\,\gamma \sin\left(\frac{\pi x}{l}\right)e^{-\gamma t} + \frac{G}{C}V_0 \sin\gamma\left(\frac{\pi x}{l}\right)\int e^{-\gamma t}$$

Simplify

$$\frac{-\pi^2}{l^2} = \frac{R}{L}V + \frac{G}{C}$$

Since TL is assumed to have negligible capacitance we can ignore $\left(\frac{G}{C}\right)$ term

$$\frac{\pi^2}{l^2} = \left(\frac{R}{L}\right)\gamma$$

$$\gamma = \frac{-\pi^2}{l^2}\frac{L}{R}$$

6. $Z_0 = 75\,\Omega$, $Z_L = 0\,\Omega$

$l = 0.1\lambda$

i. Short circuit

Smith chart

Step:1. Locate load Impedance on Smith chart

Step 2: Trace a constant electrical length curve on smith chart

$l = 0.1\lambda$

i. Analytically

$$Z_{in} = j Z_0 + \tan(\beta C)$$

iii. $\Gamma_S = -\Gamma_R$

$= 0.171 \angle 45^\circ$

iv. $Z_S = Z_0^* \frac{(1+\Gamma_S)}{(1-\Gamma_S)} = 600 \times \frac{(1+0.171\angle 45^\circ)}{(1-0.171\angle 45^\circ)}$

$Z_S \cong 475.8 \angle 21.2^\circ \Omega$

v. $V_S = V_R = 50V$

vi. $V_{max} = V_R^* \frac{(1+\Gamma_R)}{2} = 50.1 \frac{(1+(-0.171\angle 45^\circ))}{2}$

$V_{max} = 43.09 \angle -45^\circ V$

3. $Z_L = 100 + j50 \Omega$

$Z_0 = 50 \Omega$

$l = 0.4\lambda$

$Z_S = 100 \Omega$

$d = 1$

$Z_{in} = Z_0 \left[\frac{Z_L + jZ_0 \times \tan(\beta l)}{Z_0 + jZ_L \times \tan(\beta l)} \right]$

$\beta = \frac{2\pi}{\lambda}$

$\lambda = 2\pi \times \frac{\alpha}{\beta} \rightarrow \beta = \frac{2\pi}{(2\pi/\beta)}$

$\beta = \frac{1}{\frac{2\pi d}{\lambda}} = \frac{\lambda}{2\pi} = \frac{0.4}{2\pi} = 0.063$

Substitute in Z_{in}

$Z_{in} = 50 \left[\frac{(100 + j50 + j50 \times (\tan(0.063 \times 0.4\lambda))}{(50 + j(100 + j50) \tan(\beta \times 0.4\lambda)} \right]$

4. (i) $\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$

for open circuit

$Z_{oc} = \frac{Z_0(1+\Gamma)}{Z_0(1-\Gamma)}$

$Z_{in} = \frac{Z_0(Z_L + Z_{oc})}{(Z_0 + Z_{oc})}$

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$$\beta = \frac{2\pi}{0.1\lambda} = \frac{20\pi}{\lambda}$$

$$Z_{in} = 75j \tan\left(\frac{20\pi}{\lambda} 0.1\lambda\right)$$

$$= j\,75 \tan(2\pi)$$

Since $\tan(2\pi) = 0$, The input impedance for SC Load is $Z_{in} = 0\,\Omega$;

ii) Open Circuit

Smith chart

1. Locate load impedance on smith chart (∞)
2. Trace a constant length curve by $= 0.1\lambda$

$$Z_{in} = -j Z_0 \cot(\beta L)$$

Substitute

$$Z_{in} = -j\,75 \cot\left(\frac{20\pi}{\lambda} 0.1\lambda\right)$$

$= \cot(2\pi)$, It is undefined

i. for short circuit load $Z_{in} = 0\,\Omega$

ii. for open circuit, the input impedance is undefined.

7. Smith chart

$Z_L = 100 + j150\,\Omega$

$Z_0 = 75\,\Omega$

i. Normalize $= \frac{100 + j150}{75} = 1.33 + 2j$

$r = 1.33$, $x = 2$.

ii. $\Gamma = 40$

iii. VSWR $= 5$

iv. $Z_{in} = 0.4\lambda$

v. At generator $= 0.06$

8. VSWR $= 2$

Minima unknown 11, 19.

Minima for SC 16, 24

$Z_0 = 50$

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for unknown load:

$19 - 11 = 8\text{cm} = \frac{\lambda}{2}$

SC load, $24 - 16 = 8 = \frac{\lambda}{2}$

Since both measurements results assume $\frac{\lambda}{2}$, we can conclude by (λ) is 16cm. Now to calculate f

$$\lambda = \frac{c}{f}, \quad c = 3 \times 10^8, \quad \lambda = 16\text{cm} = 0.16\text{m}$$

$$0.16 = \frac{3 \times 10^8}{f} \rightarrow f = 1.875\text{GHz}$$

$$\text{VSWR} = \frac{1 + |\Gamma|}{1 - |\Gamma|} \rightarrow 2 = \frac{1 + \Gamma}{1 - \Gamma}$$

$$|\Gamma| = \frac{1}{3}$$

Γ for SC is -1, we can calculate the load impedance using

$$Z_L = \frac{Z_0 (1 + \Gamma)}{1 - \Gamma}$$

$$Z_L = 0$$

9. Given:

$Z_0 = 75\,\Omega$, $l = 0.15\lambda$, $Z_L = 100\,\Omega$

The reflection coefficient at point should be zero

$$\gamma - \beta = \frac{(Z_{in} - Z_L)}{Z_{in} + Z_L}$$

$$Z_{in} - A = Z_0 (Z_L + j Z_0 \tan(\beta l))$$

$$Z_{in} - A = 100\,\Omega$$

$$\beta = \frac{2\pi}{\lambda}$$

$$\lambda = \frac{2\pi}{\beta}$$

$$\lambda = \frac{2\pi}{2\pi/\lambda} = \lambda$$

$$Z_{in} - A = Z_0 (Z_L + j Z_0 \tan(\beta l))$$

$$= 75(100 + j\,75 \tan(\lambda 0.15))$$

$$= 75(100 + j\,75 \tan(\lambda\, 0.15))$$

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since both lines are lossless & have same phase velocity the characteristic impedance is the same at both points.

$\therefore Z_{in-\beta} = Z_0$

$\gamma\beta = \frac{Z_{in} - Z_L}{Z_{in} + Z_L}$

$= \frac{Z_{in-\beta} - Z_L}{Z_{in-\beta} + Z_L} = 0$

(Since the line is matched)

$Z_0 - Z_L = 0$

$Z_L = 75\,\Omega$

$\therefore Z_L = 75\,\Omega$, $\gamma\beta = 0$, $\lambda = \lambda$

10. Given: $Z_0 = 75\,\Omega$; $I_{max} = 0.2A$, $I_{min} = 0.08A$

$VSWR = \frac{I_{max} + I_{min}}{I_{max} - I_{min}}$

$= \frac{0.2 + 0.08}{0.2 - 0.08} = \underline{\underline{2.33}}$

Reflection coefficient

$\Gamma = \frac{VSWR - 1}{VSWR + 1} = \frac{1.33}{3.33} = 0.39$

$Z_L \Rightarrow \Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$

$Z_L = Z_0 \times \left(\frac{1+\Gamma}{1-\Gamma}\right) = 75\left(\frac{1+0.39}{1-0.39}\right)$

$Z_L = 75 \times \left(\frac{1.39}{0.61}\right) = 170.9\,\Omega$

Nearest distance to load for voltage measurement

$d = \frac{\lambda}{4}$

Given that the nearest voltage minimum is at a distance of 0.15λ

$d = 0.15\lambda + \frac{\lambda}{2}$

$d = 0.65\lambda$

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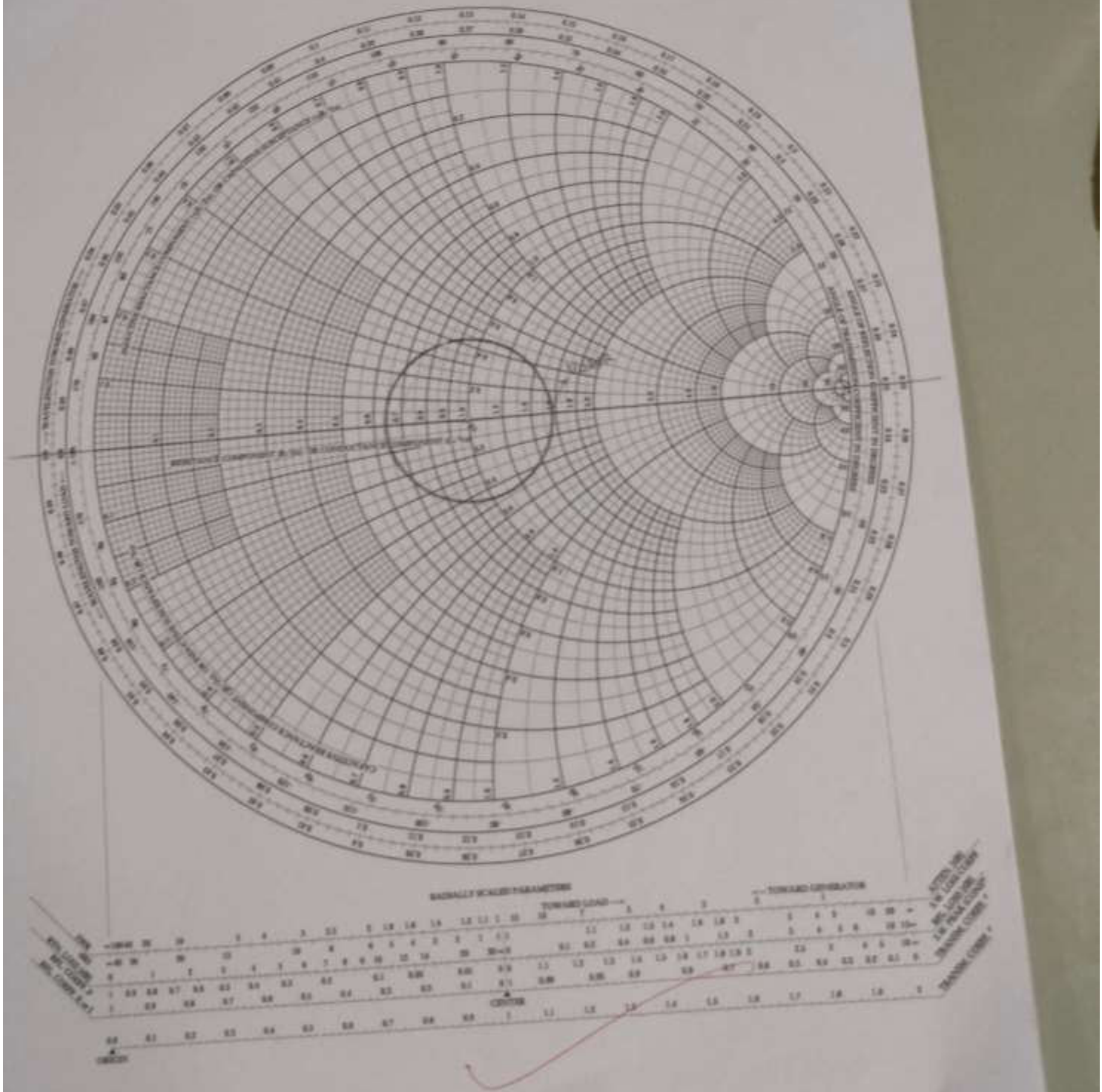
2021ECE0145

The Complete Smith Chart

Black Magic Design



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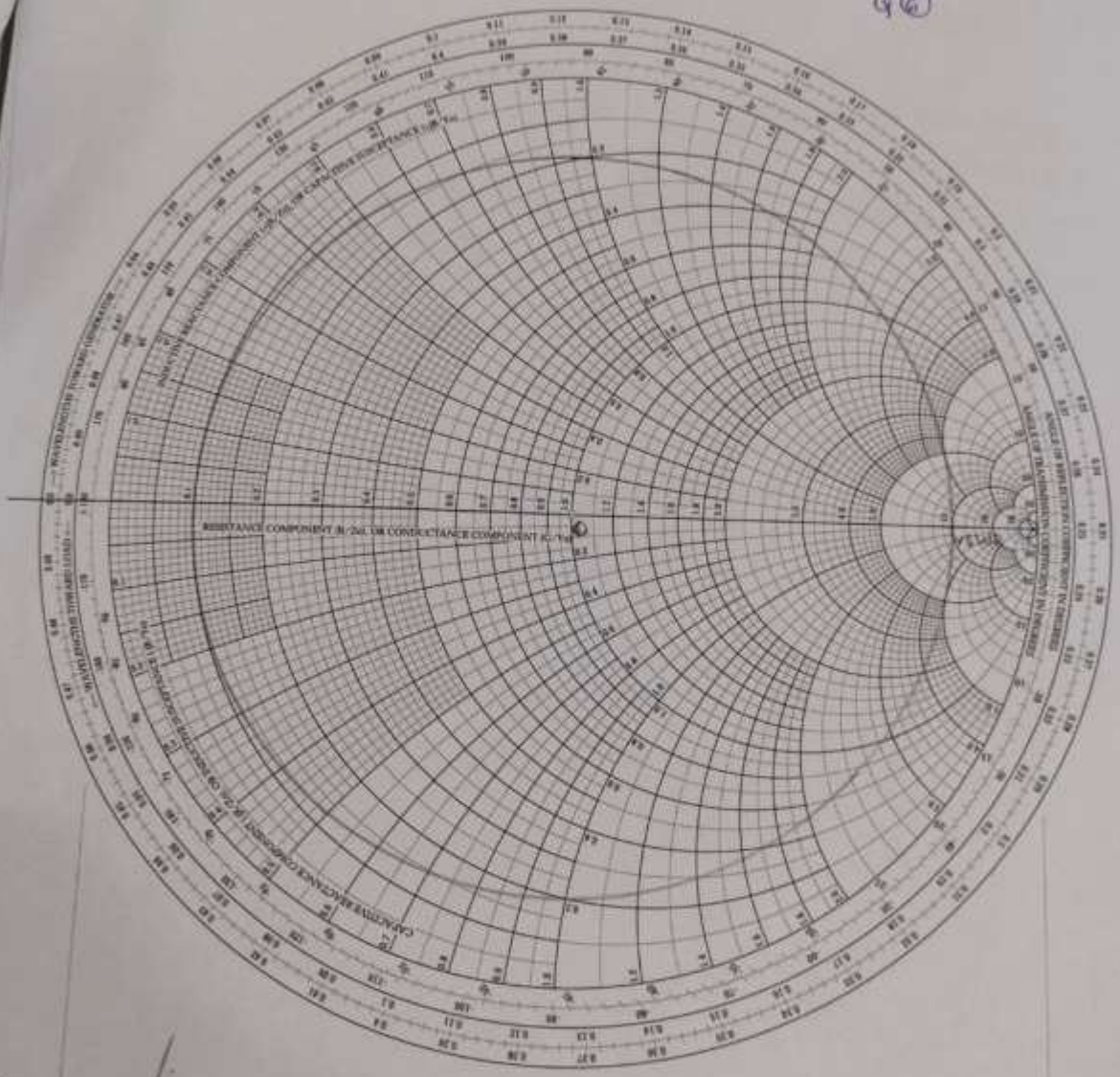
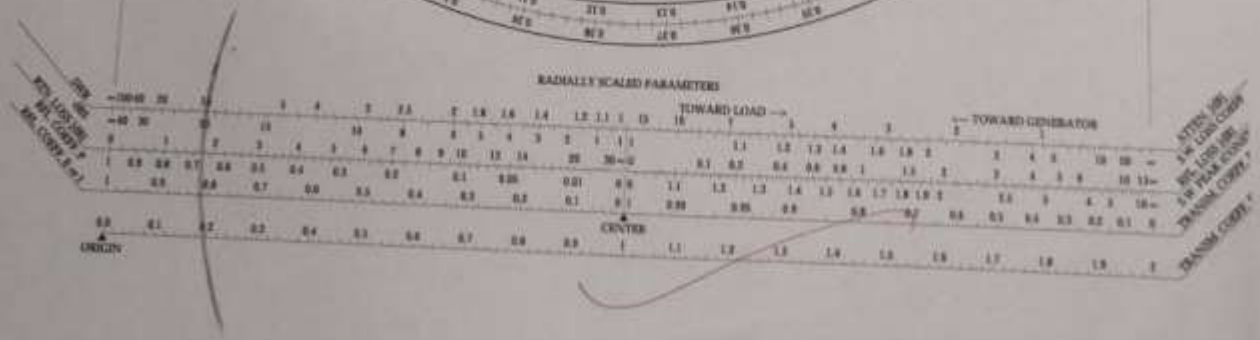
The Complete Smith Chart

Black Magic Design





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The Complete Smith Chart

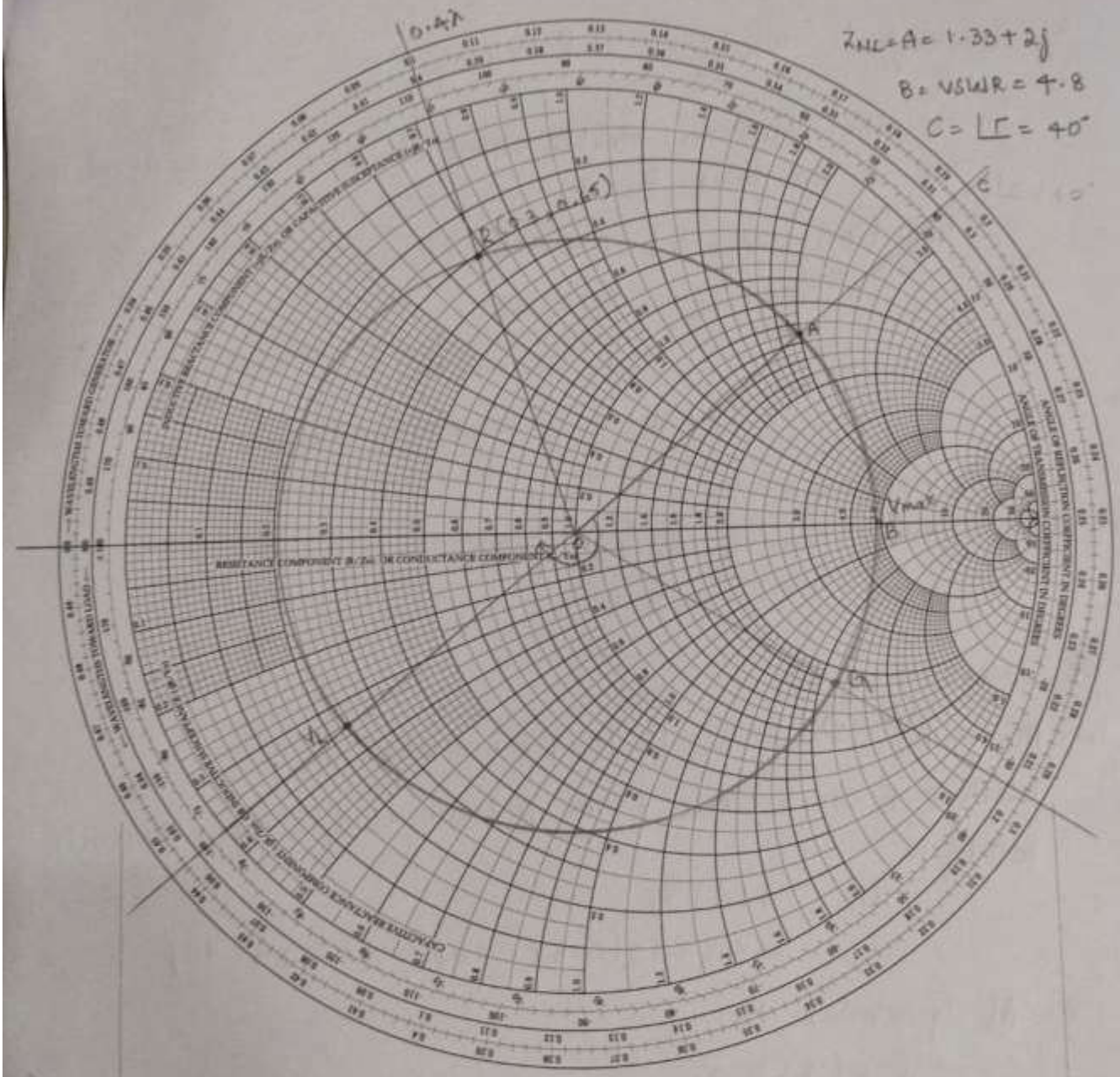
Black Magic Design

9(7)

$Z_{NL} = A = 1.33 + 2j$

B = VSWR = 4.8

C = $\angle\Gamma$ = 40°



$|\Gamma| = 0.66$

Y_L = admittance

$Y_L = 0.225 - 0.35j$

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11. For a rectangular waveguide, the cut off frequency for the TE mode is given by

$$f_c = \frac{1}{2\sqrt{a^2+b^2}}$$

$a = 6cm = 0.06m$

$b = 0.03m$

$$f_c = \frac{3\times10^8}{2\sqrt{(0.06)^2+(0.03)^2}}$$

$$f_c = \frac{3\times10^8}{0.6118}$$

$$f_c = 4.903\times10^8$$

The given signal frequency is $2\pi\times10^{10} > f_c$ (cut off - frequency)

The phase constant β is given by

$$\beta = 2\pi\times f\sqrt{\epsilon\mu - \left(\frac{f_c}{f}\right)^2}$$

$$\beta = 2\pi\times 2\pi\times10^{10}\sqrt{8.854\times10^{-12}\times4\pi\times10^{-7} - \left(\frac{5.03\times10^9}{2\pi\times10^{10}}\right)}$$

$$= 3.94\times10^{11}\times 3.32\times10^{-10}$$

$$\beta = 13.0917$$

$$Z = \sqrt{\frac{4\pi\times10^{-7}}{8.854\times10^{-18}}}\times\frac{1.992\times10^7}{2\pi\times2\pi\times10^{10}}$$

$Z = 191.43\Omega$

$P = \left(\frac{1}{2}\right)$ Real $(\epsilon^6\times\mu^4) = \epsilon_{z=0}$

$H_z = \cos\left(\frac{\pm v}{b}\right)$

$H_z = -j\left(\frac{\beta}{\omega}\right)\times\sin\left(\pi 4/b\right)$

$Hx = j(\beta/\omega)\times\sin\left(\pi 4/b\right)$

$P = 1/2\times Re(0j(\beta/\omega))$

$P = 1/2\cdot 0$

$P = 0$

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12. Electric field.

$$E(x,y,z) = E_0 \sin\left(\frac{\pi m}{a}\right) \times \cos\left(\frac{\pi n}{b}\right) \sin(\omega t)$$

Magnetic field

$$H(x,y,z) = H_0 \cos\left(\frac{\pi m}{a}\right) \sin\left(\frac{n\pi}{b}\right) \sin \omega t$$

1. Electric field.

Sinusoidal variation along the x-direction.

$$E(x,y,z) = E_0 \sin\left(\frac{\pi x}{a}\right)$$

at $x = 0$ it is SC

2. Magnetic field

Sinusoidal variation along Y-direction.

$$H(x,y,z) = H_0 \times \sin\left(\frac{\pi y}{b}\right)$$

It reaches its max value at the center of the wave guide.

3. Time variation.

Both electric & magnetic fields very sinusoidally with time, with a frequency determined by ω

Electromagnetic field in the waveguide exhibits a standing wave pattern along the x & y directions corresponding to TE_{10} mode.

The magnetic field is polarized in Y-direction

The electric field is polarized in X-direction.

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Course Code: ECE3012	**Course Title:** Information Theory and Coding **Type of Course:** Program Core Basket Theory only	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	**Basic concepts of simple Applied Statistics [MAT1003], Digital Communication [ECE3007]Mean and variance of discrete random variables, Joint probability, Probability theory** **Basic communication block diagram and its working, Channels**				
Anti-requisites	NIL				
Course Description	**The course is designed for undergraduate level students to learn about information coding in communication. The main objective of the course is to understand the basics of errorcontrol coding in the information. This course will be foundation for advanced signal processing and network security. The research potential of the subject can make students to learn and develop algorithm.Thiscourse provides an introduction to the concept of Entropy, rate of information and various source encoding algorithms. Discrete & continuous communication channels are included to get the knowledge of numerical computations in the development of communication system without any error.**				
Course Objective	**The objective of the course is to familiarize the learners with the concepts of Information Theory and Coding and attain the SKILL DEVELOPMENT through PROBLEM SOLVING.**				
Course Outcomes	**On successful completion of this course the students shall be able to:** **1. Discuss the concept of dependent and independent source, measure of information, Entropy, rate of information and order of a source.** **2. Apply the information source using Shannon encoding, Shannon Fano, encoding and Huffman encoding algorithms.** **3. Analysis of the continuous and discrete communication channels using input, output and jointprobabilities.** 4. **Analysis of a codeword comprising of the check bits computed using linear blockcodes, cyclic codes and convolutional codes.**				
Course Content					
Module 1	**Introduction to Information Theory**	Assignment/Quiz	Numerical/ Memory recall based		**10 Classes**
Topics Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Markoff Sources.					
Module 2	**Information Coding**	Assignment	Numerical		**9 Classes**
Topics Source coding theorem, Kraft McMillan Inequality property – KMI, Encoding of the Source Output, Shannon's Encoding Algorithm, Shannon Fano Encoding Algorithm, Huffman codes, Extended					

Huffman coding				
Module 3	**Information Channel**	Quiz/ Assignment	Memory recall based / Numerical	**10 Classes**

Topics

Communication Channel block diagram, Channel Matrix, Joint probability Matrix, Mutual Information, Channel Capacity, Channel Capacity of : Binary Symmetric Channel, Binary Erasure Channel, Muroga,s Theorem, Continuous Channels: Shannon's Hartley law and its numerical.

Module 4	**Error Control Coding**	Quiz/ Assignment	Memory recall based / Numerical	**10 Classes**

Topics

Error Control Coding: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error detection & Correction capabilities ofLinear Block Codes, Single error correction Hamming code, Table lookup Decoding using Standard Array.

List of Laboratory Tasks:

N**A**

Targeted Application & Tools that can be used:

Application area of Information Theory and Coding in Network Security and Computer Communication System.

Professionally used software : MATLAB

Text Book(s):

1. Digital and analog communication systems, K. Sam Shanmugam, John Wiley India Pvt. Ltd, 1996.
2. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007

Reference(s):

1. Digital Communications – Fundamentals and Applications, Bernard Sklar, Second Edition, Pearson Education, 2016, ISBN: 9780134724058.
2. Information Theory and Coding-by Dr. J. S. ChitodeTechnical Publications,First edition 2021.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. Video lectures on" Source coding theorem" by Prof: SN Merchant, IIT Bombayhttps://nptel.ac.in/courses/117101053
2. Videos on Entropy, Mutual Information, Conditional and Joint Entropyhttps://www.digimat.in/nptel/courses/video/108102117/L02.html
3. Presidency University Library Link https://presiuniv.knimbus.com/user#/home

E-content:

1. Ye Liu, Justin P. Coon"Mitigating Bit-Synchronization Errors in Huffman-Coding-Aided Index Modulation" IEEE Communications Letters (Volume: 23, Issue: 3, March 2019) https://ieeexplore.ieee.org/document/8588988/authors#authors
2. Shigeaki Kuzuoka, Shun Watanabe"An Information-Spectrum Approach to Weak Variable-Length Source Coding With Side-Information" IEEE Transactions on Information Theory (Volume: 61, Issue: 6, June 2015) **Page(s):** 3559 – 3573.https://ieeexplore.ieee.org/document/7089269
3. Distributed Source Coding Using Abelian Group Codes: A New Achievable Rate-Distortion Region,Dinesh Krithivasan;S. Sandeep Pradhan,IEEE Transactions on Information TheoryYear2011,Volume: 57, Issue: 3,Journal Article, Publisher: IEEECited by: Pages

(44)https://ieeexplore.ieee.org/document/5714261
4. Aleksandar Radonjic "Integer Codes Correcting Single Errors" IEEE Communications Letters (Volume: 22, Issue: 1, January 2018,**Page(s):** 17 - 20 https://ieeexplore.ieee.org/document/8055561

Topics relevant to "SKILL DEVELOPMENT": Information content of message, Markov Statistical Model, Source Coding, Channel Capacity, Error Control Coding for **Skill Development** through **Problem Solving** methodologies. This is attained through assessment component mentioned in course handout.

Topics relevant to development of "FOUNDATION SKILLS" : Communication system and channels

Topics relevant to "HUMAN VALUES AND PROFESSIONAL ETHICS": Designing an error free communication system.

Catalogue prepared by	Ms. Akshatha K
Recommended by the Board of Studies on	BOS Meeting NO: 15th, Dated BOS 28/07/2022
Date of Approval by the Academic Council	Academic Council Meeting No. 18th, Dated 03/08/22

NAME OF PROGRAM:B.Tech

P.R.C. APPROVALREF :

SEMESTER/YEAR : 6/3

COURSE TITLE&CODE : Information Theory and Coding & ECE3012

COURSECREDITSTRUCTURE: 3 Credits (L=3, T=0, P=0, C=3)

CONTACTHOURS : 3Hours/Week

COURSEINSTRUCTOR

PROGRAM OUTCOMES:

Graduates oftheB.Tech.PrograminElectronics and CommunicationEngineeringwillbeableto:

PO1.Engineeringknowledge:Applytheknowledgeofmathematics,science,engineeringfundamentals,andanengineeringspecializationtothesolutionofcomplexengineeringproblems(H).

PO2.Problemanalysis:Identify,formulate,reviewresearchliterature,andanalyzecomplexengineering problems reaching substantiated conclusionsusingfirst principles of mathematics,naturalsciences,andengineeringsciences(H).

PO3. Design/development of solutions: Design solutions for complex engineering problems anddesignsystemcomponentsorprocessesthatmeetthespecifiedneedswithappropriateconsiderationforthepublichealthandsafety,andthecultural,societal, andenvironmentalconsiderations(M).

PO4.Conductinvestigationsofcomplexproblems:Useresearch-basedknowledgeandresearchmethodsincluding design of experiments, analysis and interpretation of data, and synthesis of the information toprovidevalidconclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modernengineeringandITtoolsincludingpredictionandmodelingtocomplexengineeringactivities withanunderstandingofthelimitations(H)

PO6.Theengineerandsociety:Applyreasoninginformedbythecontextualknowledgetoassesssocietal,health, safety, legal and cultural issues and the consequent responsibilities relevant to the professionalengineeringpractice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutionsin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainabledevelopment.

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PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities andnormsofthe engineeringpractice(H).

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader indiverseteams,andinmultidisciplinarysettings.

PO10.Communication:Communicateeffectivelyoncomplexengineeringactivitieswiththeengineering community and with society at large, such as, being able to comprehend and writeeffectivereportsanddesigndocumentation,makeeffectivepresentations,andgiveandreceive clearinstructions(M).

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineeringandmanagementprinciplesandapplythesetoone'sownwork,asamemberandleaderinateam,tomanageprojectsandinmultidisciplinaryenvironments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage inindependentandlife-longlearninginthebroadest contextoftechnologicalchange(L).

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COURSE PREREQUISITES:

Basic concepts of simple Applied Statistics Digital Communication Mean and variance of discrete random variables, Joint probability, Probability theory

COURSE DESCRIPTION:

The course is designed for undergraduate level students to learn about information coding in communication. The main objective of the course is to understand the basics of error control coding in the information. This course will be foundation for advanced signal processing and network security. The research potential of the subject can make students to learn and develop algorithm. This course provides an introduction to the concept of Entropy, rate of information and various source encoding algorithms. Discrete & continuous communication channels are included to get the knowledge of numerical computations in the development of communication system without any error.

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5. **Discuss the concept of dependent and independent source, measure of information, Entropy, rate of information and order of a source.**
6. **Apply the information source using Shannon encoding, Shannon Fano, encoding and Huffman encoding algorithms.**
7. **Analysis of the continuous and discrete communication channels using input, output and joint probabilities.**
8. **Analysis of a code word comprising of the check bits computed using linear block codes, cyclic codes and convolutional codes.es.**

MAPPING OF C.O. WITH P.O

PO→ CO	1	2	3	5	8	10	12
1	H	H	M	H	H	M	L
2	H	H	M	H	H	M	L
3	H	H	M	H	H	M	L
4	H	H	M	H	H	M	L

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COURSE CONTENT (SYLLABUS):

Module 1:Introduction to Information Theory [10Hrs.][Bloom's levelselected:Comprehension]

Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Markoff Sources.

Module 2: Information Coding [9Hrs.][Bloom's levelselected:Comprehension]

Source coding theorem, Kraft McMillan Inequality property – KMI, Encoding of the Source Output, Shannon's Encoding Algorithm, Shannon Fano Encoding Algorithm, Huffman codes, Extended Huffman coding.

Module 3: Information Channel [10Hrs.]Bloom's level selected: Application]

Communication Channel block diagram, Channel Matrix, Joint probability Matrix, Mutual Information, Channel Capacity, Channel Capacity of : Binary Symmetric Channel, Binary Erasure Channel, Muroga,s Theorem, Continuous Channels: Shannon's Hartley law and its numerical.

Module 4:Error Control Coding [10Hrs.]Bloom's level selected: Application]

Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error detection & Correction capabilities ofLinear Block Codes, Single error correction Hamming code, Table lookup Decoding using Standard Array.

SKILL SETS TO BE DEVLOPED:

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. **Ability to interpret events and results.**
4. **Ability to work as a leader and as a member of a team.**
5. **Assess errors in systems/processes/programs/computations and eliminate them.**
6. Observe and measure physical phenomena**.**
7. **Write reports.**
8. **Se**lect suitable equipment, instrument, materials & software
9. **Locate faults in system/Processes/software.**
10. **Manipulative skills for setting and handling systems/Process/Issues**
11. **The ability to follow standard /Legal procedures.**
12. **An awareness of the Professional Ethics.**
13. **Need to observe safety/General precautions.**
14. To judge magnitudes/Results/issues without actual measurement/actual contacts

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DELIVERY PROCEDURE (PEDAGOGY):

Lectures will be conducted with the aid of multi-media projector, blackboard, etc. Assignments based on coursecontentswillbegiventothestudentsattheendofeachunit/topicandwillbeevaluatedatregular interval

Self-Learning Topics:

Modern Direct-Conversion Transmitters, Heterodyne Transmitters, OOK Transceivers

REFERENCE MATERIALS:

(I) TextBOOK(S)

3. Digital and analog communication systems, K. Sam Shanmugam, John Wiley India Pvt. Ltd, 1996.
4. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007

(II) Reference Book(S)

3. Digital Communications – Fundamentals and Applications, Bernard Sklar, Second Edition, Pearson Education, 2016, ISBN: 9780134724058.
4. Information Theory and Coding-by Dr. J. S. ChitodeTechnical Publications,First edition 2021.

(III) Class Notes / Online Resources

4. Video lectures on" Source coding theorem" by Prof: SN Merchant, IIT Bombayhttps://nptel.ac.in/courses/117101053
5. Videos on Entropy, Mutual Information, Conditional and Joint Entropyhttps://www.digimat.in/nptel/courses/video/108102117/L02.html
6. Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

E-content

- https://ieeexplore.ieee.org/document/8588988/authors#authors
- https://ieeexplore.ieee.org/document/5714261
- https://ieeexplore.ieee.org/document/8055561
- https://nptel.ac.in/content/syllabus_pdf/117102012.pdf

(III) GUIDELINES TOSTUDENTS:

1. Students are required to maintain classwork which will be evaluate at the end of every month
2. Students are required to strictly adhere to assignment deadlines.
3. Students are required to actively participate in classroom discussions and other activities which is planned in the classroom**.**
4. Students are required to have minimum of 75% of attendance to be eligible to attend exam.
5. Follow NPTELvideos

(VI) Presidency University Library Link :- https://presiuniv.knimbus.com/user#/home

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COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
1.	Over View of the course			1
2.	Module : 01			06
3.	Module: 02			08
4.	Mid Term			-
5.	Module:03			08
6.	Module:04			08
7.	Course integration, Program integration and revision			3
8.	Assignment			1
9.	Quiz			----
10.	Assignment			----
11.	Instruction last day			1

SCHEDULE OF INSTRUCTION:

Sl. No.	Session No./Date*	Titleofthe lesson	Topicstobecovered	Cos	Delivery Mode	Reference
1.			Programintegration		LECTURE	
2.		Introduction toInformation Theory	DefinitionofInformation	1	LECTURE	T1,R1& CN
3.			AverageInformationContent of SymbolsinlongIndependentSequences(Entropy)	1	LECTURE	T1,R1 &CN
4.		InformationRate	InformationRate	1	LECTURE	T1,R1& CN
5.			AverageInformationContentofSymbols inlongDependent Sequences	1	LECTURE	T1,R1 &CN
6.		Significanceof MarkoffModel	MarkoffModel	1	LECTURE	T1,R1& CN
7.			RepresentationofMarkoff SourceGraphRepresentation	1	LECTURE	T1,R1 &CN
			Markov Statistical Model of Information Sources		LECTURE	T1,Ch2
8.		Gain knowledgeabout memorylesschannels	RateofInformation Transmission Over a DiscreteChannel	2	LECTURE	T1,R1 &CN
9.			CapacityofaDiscrete MemorylessChannel	2	LECTURE	T1,R1& CN
10.		Channel CodingTheorem	ChannelCodingTheorem (Shannon'sSecondTheorem)	2	LECTURE	T1,R1& CN
11.			DiscreteChannelswithMemory	2	LECTURE	T1,R1& CN

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12.			Review of previous conceptsand discussiononoutcomeof previousclasses	2	LECTURE	
13.		Entropyanditsproperties	PropertiesofEntropy	2	LECTURE	T1,R1& CN
14.			ExtensionofDiscrete MemorylessSource	2	LECTURE	T1,R1& CN
			CourseIntegration		LECTURE	
15.		Understand thesource codingalgorithms	SourceCodingTheorem (Shannon'sFirstTheorem)	1	LECTURE	T1,R1& CN
16.			CodeRedundancy,Code Variance	1	LECTURE	T1,R1& CN
17.		Shannon-Fano andHuffmanCoding	Shannon-FanoAlgorithm	1	LECTURE	T1,R1& CN
18.			HuffmanCoding	2	LECTURE	T1,R1& CN
19.		Mutual Information	MutualInformationandProperties ofMutual Information	2	LECTURE	T1,R1& CN
20.			ChannelCapacity	2	LECTURE	T1,R1& CN
21.		Rationale forCoding	Introduction,Rationalefor CodingandTypes andCodes	2	LECTURE	T1,R1 &CN
22.			Reviewofprevious concepts	2	LECTURE	T1,R1 &CN
23.		Discrete Memoryless Source	DiscreteMemorylessChannels	2	LECTURE	T1,R1 &CN
24.		Error control coding techniques – Linear Blockcodes	Typesof Errors	3	LECTURE	T1,R1& CN
25.			Linear Block Codes, MatrixDescriptionofLinearBlocks Codes	3	LECTURE	T1,R1 &CN
26.		HammingCodes	HammingCodes	3	LECTURE	T1,R1& CN
27.			ErrorDetectionandCorrection CapabilitiesofHammingCodes	3	LECTURE	T1,R1& CN
28.			Encoderof(7,4)HammingCode	3	LECTURE	T1,R1& CN
29.		Syndrome Decodingprocedure	SyndromeDecoding	3	LECTURE	T1,R1& CN

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30.			ErrorCorrectionUsing SyndromeVector	3	LECTURE	T1,R1& CN
31.			SyndromeDecoderfora(n,k) BlockCode	3	LECTURE	T1,R1& CN
32.			OtherLinearBlockCodes	3	LECTURE	T1,R1& CN
33.			Reviewofprevious classes and discussiononoutcomeofprevious classes	3	LECTURE	
			Lempel - Ziv Algorithm		LECTURE	R1,Ch3
			Course Integration		LECTURE	
34.		Conceptsoferrorcontrolcoding	SingleParityCheckBitCode	3	LECTURE	T1,R1& CN
35.			BinaryCyclicCodes,Definition ofCyclicCodes	3	LECTURE	T1,R1& CN
36.		CyclicCodesanditsProperties	PropertiesofCyclicCodes; AlgebraicStructuresofCyclicCodes	3	LECTURE	T1,R1 &CN
37.			Generator andParityCheckMatricesofCyclic Codes	3	LECTURE	T1,R1& CN
38.			GeneratorMatrix,ParityCheck Matrix	3	LECTURE	T1,R1& CN
39.			Test-II:Review		LECTURE	
40.			Reviewofpreviousclassesanddiscussiononoutcomeof previousclasses	3	LECTURE	
41.		Encoding Usingan (n - k) BitShift Register	EncodingUsingan(n- k) Bit ShiftRegister	3	LECTURE	T1,R1& CN
42.			BlockDiagramofSyndrome Calculator	3	LECTURE	T1,R1& CN
43.		BCHCodes	DecoderforCyclicCodes	3	LECTURE	T1,R1& CN
44.			BCHCodes(Bose-Chaudhuri-HocquenghemCodes)	4	LECTURE	T1,R1& CN
45.		RSCodes,GolayCodes	Reed-Solomon(RS)Codes, GolayCodes	4	LECTURE	T1,R1 &CN
			Table lookup Decoding using		LECTURE	R1,Ch3

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			Standard Array			
46.		Convolutional Codes	ConvolutionalCodes,Definitionof ConvolutionalCoding,Code RateofConvolutionalEncoder	4	LECTURE	T1,R1 &CN
47.			ConstraintLength(K)	4	LECTURE	T1,R1& CN
48.			Dimensionof theCode	4	LECTURE	T1,R1& CN
			Design of syndrome calculator for higher order		LECTURE	R1,Ch3
49.		Code Tree,Trellis and StateDiagram	CodeTree,TrellisandState DiagramforaConvolutionalEncoder	4	LECTURE	T1,R1 &CN
50.			StatesoftheEncoder	4	LECTURE	T1,R1& CN
51.			DevelopmentoftheCodeTree, StateDiagram	4	LECTURE	T1,R1& CN
52.		Viterbi Algorithmfor Decoding ofConvolutionalCodes	DecodingMethods of ConvolutionalCodes	4	LECTURE	T1,R1& CN
53.			ViterbiAlgorithmforDecoding ofConvolutionalCodes	4	LECTURE	T1,R1& CN
54.			ViterbiAlgorithmforDecoding ofConvolutionalCodes	4	LECTURE	T1,R1& CN
55.			(MaximumLikelihood Decoding)	4	LECTURE	T1,R1& CN
56.			SequentialDecodingfor ConvolutionalCodes	4	LECTURE	T1,R1& CN
57.			SequentialDecodingfor ConvolutionalCodes	4	LECTURE	T1,R1& CN
58.			SequentialDecodingfor ConvolutionalCodes	4	LECTURE	T1,R1& CN
59.			AdvantagesandDisadvantages ofConvolutionalCodes	4	LECTURE	T1,R1& CN
60.			RevisionforEndtermExam		LECTURE	
61.			RevisionforEndtermExam		LECTURE	

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Topics relevant to "SKILL DEVELOPMENT": Information content of message, Markov Statistical Model, Source Coding, Channel Capacity, Error Control Coding for **Skill Development** through **Problem Solving** methodologies. This is attained through the **Assignment** as mentioned in the assessment component.

ASSESSMENT SCHEDULE FOR THEORY COMPONENT:

Sl. no	Assessment type	Contents	Course outcome Number	Duration In Hours	marks	Weightage (%)	Venue, DATE &TIME
1	Assignment	Module 1,2	CO1 & CO2	-	25	12.5	Hardcopy
2	Assignment Review of digital / e-resources from Pres. Univ. link given in the References Section - (Mandatory to submit screenshot accessing digital resource. Otherwise it will not be evaluated)	1. https://ieeexplore.ieee.org/document/5090623\ 2. https://ieeexplore.ieee.org/document/5472888 3. https://ieeexplore.ieee.org/document/5568178 4. https://ieeexplore.ieee.org/document/544005	CO1& CO2	-	25	12.5	Will be announced one week prior to submission
3	Midterm	Modules 1,2	1,2	1.5	50	25	
5	End Term Exam	Modules 1 to 5	1,2,3,4	3	100	50	

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COURSE CLEARANCE&EVALUATION CRITERIA:

A minimum of 75% attendance is required for both lab and theory separately to attend the end term exam. Make-up policy will be only as per academic regulation.

MethodofAssessment forCourseswithCreditStructure(L –T –0)or(L– 0–0)			
	ComponentsofContinuousAssessments	**Weightage(% of TotalMarks)**	**DurationofAssessment**
1.	MidTerm	25%	1.5hour
2.	ThisComponentofcontinuousassessmentshallconsistofatleastTWO(02)of thefollowing: (1) Assignment(s) (2) Quiz	25%	NA
3.	EndTermFinalExaminations	50%	3hours
Total		**100%**	

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS:

It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

Target set for course Outcome attainment:

Sl.NO	CO NO.	CourseOutcomes	Targetsetfor attainment inpercentage
01	CO1	Describethefundamentalsofcodingtheoryanddemonstratethe concept ofsourcecoding.	80%
02	CO2	Illustratethevariouschannelcodingtheorem.	75%
03	CO3	Analyzethelinearblockcodesforerrorcontrolcoding techniques.	80%
04	CO4	Designtheconvolutionalcodesusingencodinganddecoding techniques.	75%

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Signature of the course Instructor

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
1	Over View of the course			
2	Module : 01			
3	Module: 02			
4	Assignment			
5	Mid Term Exam			
6	Module:03			
7	Module:04			
8	Quiz			

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl.NO	CO NO.	CourseOutcomes	Targetsetfor attainment inpercentage
01	CO1	Describethefundamentalsofcodingtheoryanddemonstratethe concept ofsourcecoding.	80%
02	CO2	Illustratethevariouschannelcodingtheorem.	75%
03	CO3	Analyzethelinearblockcodesforerrorcontrolcoding techniques.	80%
04	CO4	Designtheconvolutionalcodesusingencodinganddecoding techniques.	75%

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Program Outcome Attainment:

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

Signature of the course Instructor MrsAkshatha K

D.A.C. observation and approval:

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BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate,	making judgments based on internal evidence or external criteria

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	predict, rate, select, summarize, support, value	

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GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

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Private University Estd. in Karnataka State by Act No. 41 of 2013

SCHOOL of ENGINEERING
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Year: 2022-2023 (ODD) **Semester:VI** **Section: 6ECE4**

Course Title	**:** Information theory and Coding
Course Code	**:** ECE3012
Type of Skill	**:** Skill Development
Type of Activity	**:** Problem Solving
Instructor in Charge	**:Ms.Ashwini B**
Instructor for Section	**: Ms.Ashwini.B**
Details about the activity	**:** Students were asked to submit assignment

Assignment1

1) Consider the state diagram of the Markov source with a source S = {A, B, C, D} as shown in Fig. 1.
   (i) Compute the state probabilities using state equations.
   (ii)Find the entropy of each state and source entropy.
   (iii) Find the entropy of the adjoint source.
   (iv) Find G1, G2 and Verify that G1>G2>H

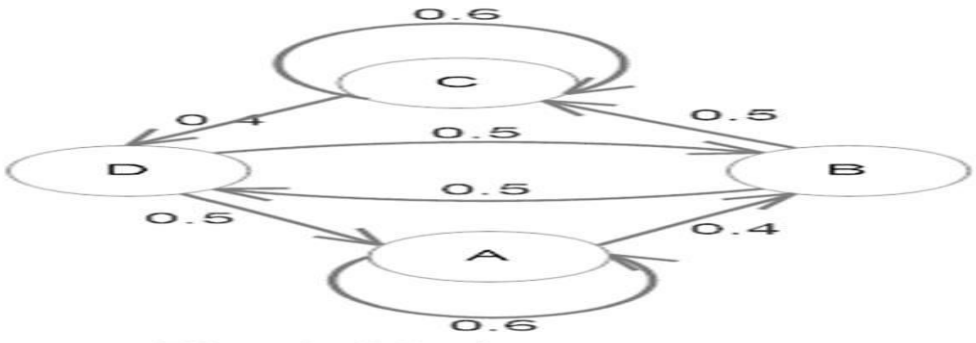

Fig. 1: Markov source

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2) Markov Chain is a statistical model used to explain randomly changing systems where it is assumed that future states do not depend on past state but depend on their current state.Also it often used to model the probabilities of different states and the rates of transitions among them. Sketch the Markov Chain to predict the weather of tomorrow using given current statistics.

Model has only 3 states:= $S\{1, S2, S3\}$ and the name ofeach state is $S1$ = Sunny, 2 =Rainy $S3$ = Cloudy.

To establish the transition probabilities relationship between states following transition probabilities are taken.

P11=0.8,P12=0.05,P13=0.15,P21=0.2,P22=O.6,P23=0.2,

P31=0.2,P32=0.3,P33=0.5

i)What will be the average information content of states if p(1)=p(2)=p(3)=1/2

ii) Estimate source entropy for the designed markov model

iii)Average information content per symbol G1 & G2

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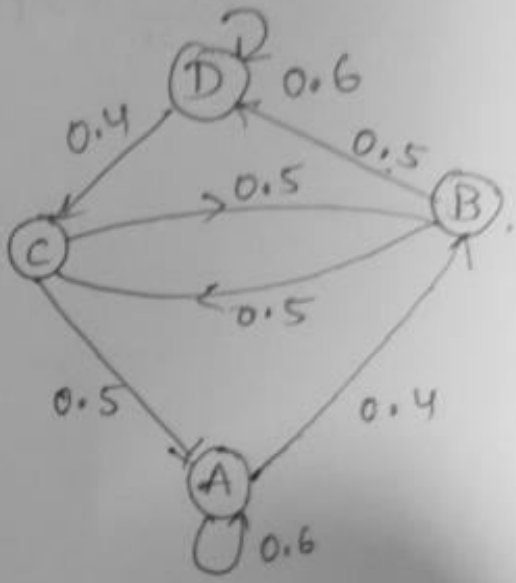
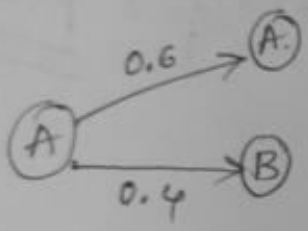
Prema Joshi / 2020ECE0222.
6ECE4

Consider the state diagram of 10 mark of source $S = \{A, B, C, D\}$ as shown in figure.

find :) state probability
ii) Entropy
iii) G_1 & G_2



Sol: $P(A) + P(B) + P(C) + P(D) = 1$



$P(A) = 0.4P(A) + 0.4P(B) \rightarrow (1)$

$P(B) = 0.4P(A) + 0.5P(C) \rightarrow (2)$

$P(C) = 0.5P(B) + 0.4P(C) \rightarrow (3)$

$P(D) = 0.6P(D) + 5P(B) \rightarrow (4)$

$0.4P(A) = 0.5P(D) \rightarrow (5)$

$0.4P(D) = 0.5P(B) \rightarrow (6)$

Now eq (1) + eq (2) $\Rightarrow$ we get

$P(A) + P(B) = 1.0P(A) + 1.0P(C) \Rightarrow P(A) + P(B) =$

Now, we eq (3) + eq (4) $\Rightarrow \boxed{P(B) = P(D)}$

$\Rightarrow$ eq ⑤ + eq ⑥ $\Rightarrow$

$$0.4\,P(A) + 0.4P(A) = 0.5P(C) + 0.5P(D)$$

$$0.4\,[P(A)+P(D)] = 0.5\,[P(C)+P(D)]$$

$$0.4\,[P(A)+P(D)] = 0.5\,[2P(B)]$$

$$P(A)+P(B) = \frac{P(B)}{0.4}$$

eq ④, $P(A)+P(B)+P(C)+P(D)=1$

$$\frac{P(B)}{0.4} + 2P(B) = 1 \Rightarrow P(B) + 0.8P(B) = 0.4$$

$$0.8P(B) = \frac{0.4}{P(B)}$$

$$P(B) = \frac{0.4}{1.8}$$

$$P(B) = \frac{2}{9}$$

$$P(B) = \frac{2}{9} = P(C)$$

$\Rightarrow$ From eq ⑤, ie,

$$0.4P(A) = 0.5P(C)$$

Sub $P(C) = \frac{2}{9}$ in eq ⑤, we get

$$0.4P(A) = 0.5\left(\frac{2}{9}\right)$$

$$0.4P(A) = \frac{1}{9}$$

$$P(A) = \frac{0.5 \times 2}{0.4 \times 9} = P(A) = \frac{5}{18}$$

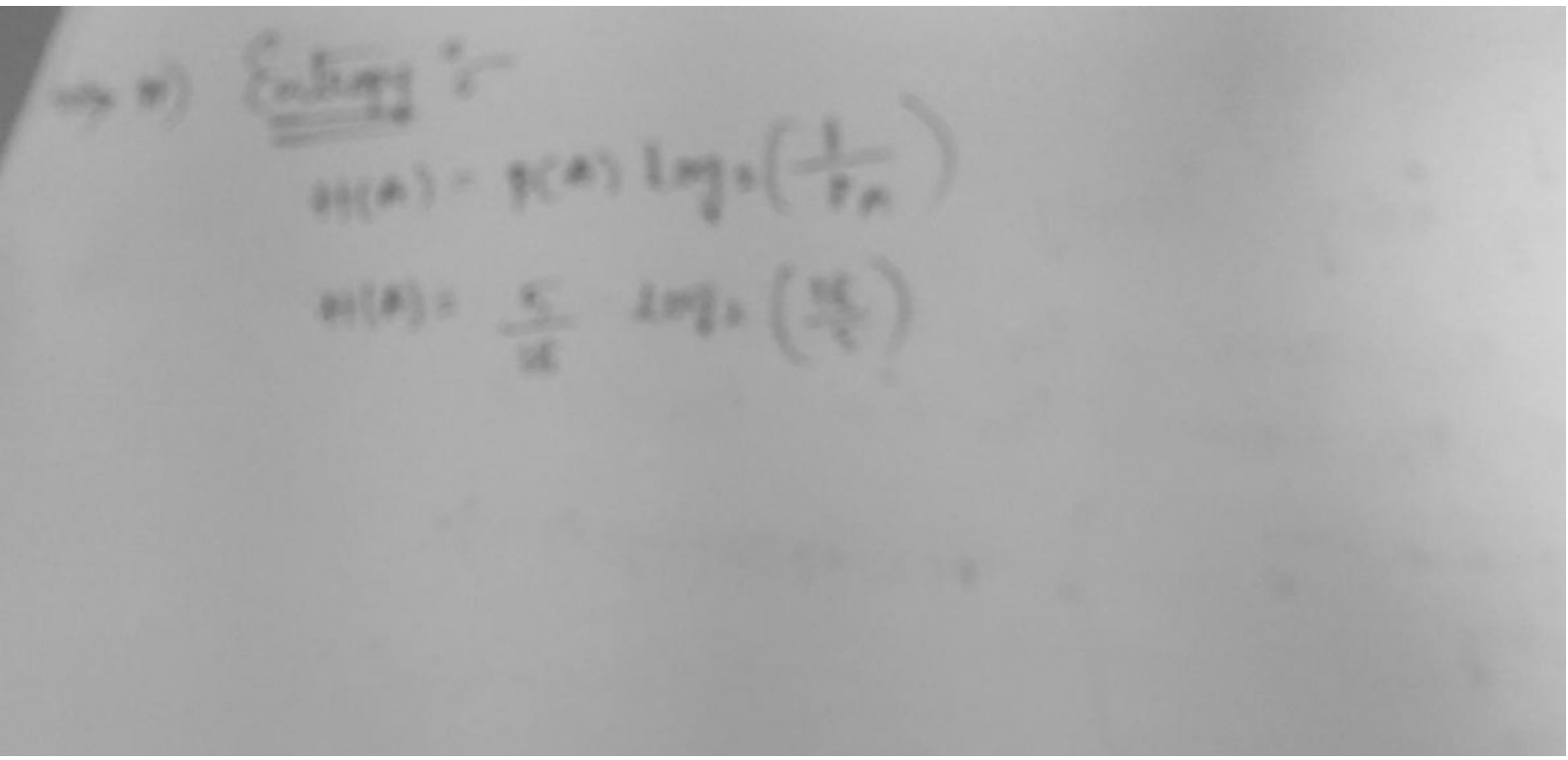
$\therefore$ $\boxed{P(A) = \frac{5}{18}}$; $\boxed{P(D) = \frac{5}{18}}$

i) State probability

$P(A) = 5/18$ $\quad$ $P(D) = 5/18$

$P(B) = 2/9$

$P(C) = 2/9$



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(2) $S = \{S_1, S_2, S_3\}$

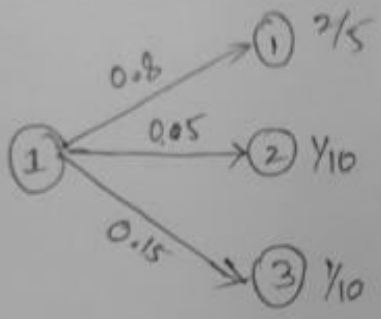
S_1 → Sunny, S_2 → Rainy, S_3 → Cloudy

$P_{11} = 0.8$, $P_{12} = 0.05$, $P_{13} = 0.15$, $P_{21} = 0.2$, $P_{22} = 0.6$, $P_{23} = 0.2$, $P_{31} = 0.2$, $P_{33} = 0.5$, $P_{32} = 0.3$

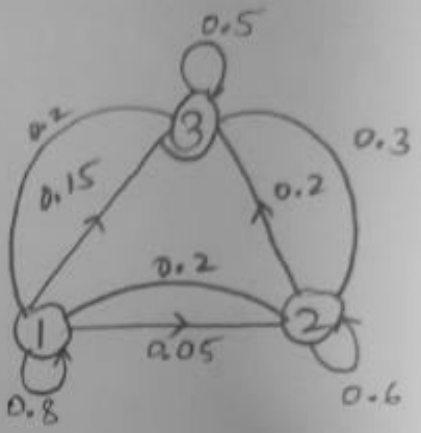
i) State probability
ii) Entropy
iii) G_1 & G_2

$\Big\}$ $P(1) = P(2) = P(3) = 1/2$

→



1st-state

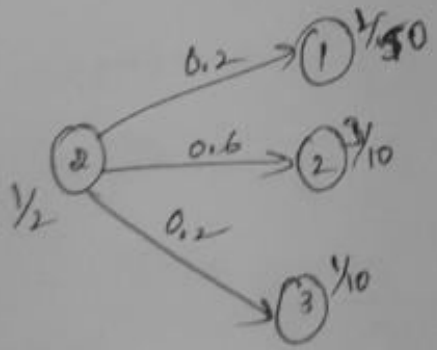


→ $P(1) = 0.8P(1) + 0.2P(2) + 0.2P(3)$

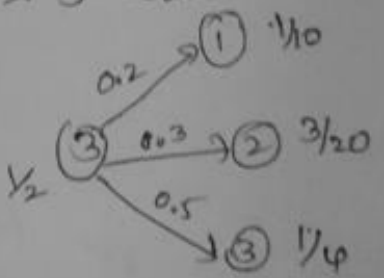
$P(2) = 0.05P(1) + 0.6P(2) + 0.3P(3)$

$P(3) = 0.15P(1) + 0.2P(2) + 0.5P(3)$

2nd-state ★



★ 3rd-state



★ $H_{11} = P_{11}\log_2(1/P_{11}) + P_{12}\log_2(1/P_{12}) + P_{13}\log_2(1/P_{13})$

$= 1.93$ bits/msg symbols

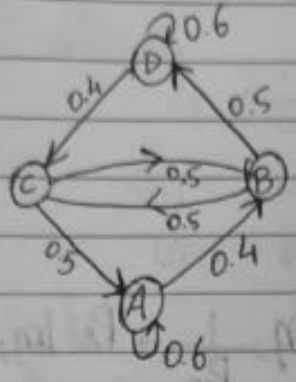
$$H_{12} = P_{32} \log_2 \left(1/P_{22}\right) + P_{23} \log_2 \left(1/P_{23}\right) + P_{23} \log_2 \left(1/P_{23}\right)$$

$$= 1.06 \text{ bits/sym}$$

$$H_{13} = P_{31} \log_2 \left(1/P_{31}\right) + P_{32} \log \left(1/P_{32}\right)$$

YOGESH.S
2020IECE0204
6ECE4

Consider the state diagram of markov's chain
$S = \{A, B, C, D\}$
i) State probability
ii) entropy
iii) $G_1 + G_2$



Sol/ From the block diagram, state equations can be written as

$P(A) = 0.6P(A) + 0.5P(D)$ - ①
$P(B) = 0.4P(A) + 0.5P(D)$ - ②
$P(C) = 0.6P(C) + 0.5P(B)$ - ③
$P(D) = 0.4P(C) + 0.5P(B)$ - ④

As there are four unknowns, we can represent one state in terms of other state

i.e ① $\Rightarrow 0.4P(A) = 0.5P(D)$

$P(A) = 1.25P(D)$

③ $\Rightarrow 0.4P(C) = 0.5P(B)$

$P(C) = 1.25P(D)$

④ $\Rightarrow P(D) = 0.4 \times 1.25P(D) + 0.5P(B)$

$P(D) = 0.5P(D) + 0.5P(B)$

$0.5P(D) = 0.5P(B)$

$\therefore P(B) = P(D)$

WKT; $P(A) + P(B) + P(C) + P(D) = 1$

$1.25P(D) + P(D) + 1.25P(D) + P(D) = 1$

$4.25P(D) = 1$

$P(D) = \frac{2}{9}$ | $P(B) = \frac{2}{9}$

$P(A) = P(C) = 1.25\,P(D)$

$= 1.25 \times \frac{2}{9}$

$$\boxed{P(A) = P(C) = \frac{5}{18}}$$

ii) Entropy of each state is

$$H_i = \sum_{j=1}^{n} P_{ij} \log_2 \frac{1}{P_{ij}}$$

$$H_A = P_{AA} \log_2 \frac{1}{P_{AA}} + P_{AB} \log_2 \frac{1}{P_{AB}} + P_{AC} \log_2 \frac{1}{P_{AC}} + P_{AD} \log_2 \frac{1}{P_{AD}}$$

$H_A = 0.971$ bits/symbol

$$H_B = P_{BA} \log_2 \frac{1}{P_{BA}} + P_{BB} \log_2 \frac{1}{P_{BB}} + P_{BC} \log_2 \frac{1}{P_{BC}} + P_{BD} \log_2 \frac{1}{P_{BD}}$$

$H_B = 1$ bits/symbol

$$H_C = P_{CA} \log_2 \frac{1}{P_{CA}} + P_{CB} \log_2 \frac{1}{P_{CB}} + P_{CC} \log_2 \frac{1}{P_{CC}} + P_{CD} \log_2 \frac{1}{P_{CD}}$$

$H_C = 0.97$ bits/symbol

$$H_D = P_{DA} \log_2 \frac{1}{P_{DA}} + P_{DB} \log_2 \frac{1}{P_{DB}} + P_{DC} \log_2 \frac{1}{P_{DC}} + P_{DD} \log_2 \frac{1}{P_{DD}}$$

$H_D = 1$ bits/sym

Entropy of source $H(S) = \sum_{j=1}^{n} P_i H_i$

$$H(S) = P(A) \cdot H_A + P(B) \cdot H_B + P(C) \cdot H_C + P(D) H_D$$

$$= \frac{5}{18} \times 0.971 + \frac{2}{9} \times 1 + \frac{5}{18} \times 0.971 + \frac{2}{9} \times 1$$

$H(S) = 0.939$ bits/sym

iii) Entropy of each interval of all the state

$$G_N = \frac{1}{N} \sum_i P_i \log_2 \left(\frac{1}{P_i}\right)$$

for 1st interval

$$4 \times \frac{1}{4} \log_2 \frac{4}{2}$$

$$G_{11} = 2 \text{ bits/memory}$$

$$G_{12} = 1.0575 + 0.8843 + 2$$

$$= 3.9418 \text{ bits/memory}$$

2) $S = \{S_1, S_2, S_3\}$

↓ Sunny ↓ Rainy ↓ Cloudy

$P_{11} = 0.8, P_{12} = 0.05$	$P_{22} = 0.6$	$P_{31} = 0.2$	$P_{33} = 0.5$
$P_{13} = 0.15, P_{21} = 0.2$	$P_{23} = 0.2$	$P_{32} = 0.3$	$P(1) = P(2) = P(3) = 1/2$

$$H(1) = 0.8 \log \frac{1}{0.8} + 0.05 \log \frac{1}{0.05} + 0.15 \log_2 \frac{1}{0.15}$$

$$= 0.25 + 0.216 + 0.41$$

$$= 0.8883$$

$$H(2) = 0.2 \log_2 \frac{1}{0.2} + 0.6 \log_2 \frac{1}{0.6} + 0.2 \log \frac{1}{0.2}$$

$$= 0.46 + 0.44 + 0.46$$

$$H(2) = 1.36$$

Course Code: ECE3020	**Course Title:** Computational Intelligence and Machine Learning **Type of Course:** Discipline Elective General Basket Theory	**L- P- C**	3	0	3
Version No.	2.0				
Course Pre-requisites	Basic concepts of matrix operations, probability theory, vector and array representation.				
Anti-requisites	**NIL**				
Course Description	The course aims to make the students to understand the mathematical approaches for machine learning and computational intelligence algorithms. This course covers the basic concepts of Neural Networks which will enable the students to understand the concepts of machine learning. Concepts of Linear models for regression and classification will be discussed in such way that students can able to perform data analysis in practical applications. In this course, Computational intelligence algorithms are included to get better understanding of Artificial intelligence.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of Computational Intelligence and Machine Learning and attain **EMPLOYABILITY SKILLS** through **PROBLEM SOLVING**.				
Course Outcomes	On successful completion of the course the students shall be able to: 1. Analyze and fundamental concepts of neural networks 2. Implement ML algorithms to regression, classification, clustering, and dimensionality reduction 3. Categorize the various pattern recognition techniques using machine learning into supervised and unsupervised.				
Course Content:					
Module 1	Fundamentals of ANN	Assignment	Memory Recall based Quizzes	**13** *Sessions*	
Topics: Introduction To Artificial Neural Networks (ANNs), Models Of A Neuron, Neural Networks- Associated Graphs And Feedback, Network Architectures And Knowledge Representation, Learning Algorithms. Perceptron, Perceptron Convergence Theorem, Relation Between The Perceptron And Bayes Classifier For A Gaussian Environment, and The Back-Propagation Algorithm. Introduction to Recurrent Neural networks					
Module 2	Regression and classification	Assignment/mini project	Memory Recall based Quizzes	**13** *Sessions*	
Topics: Linear models for regression and classification: Polynomial curve fitting. Probability theory- Bayesian probabilities, and Gaussian distribution, Linear basis function models for regression - Maximum likelihood and least squares, Regularized least squares, Bias variance decomposition-Bayesian linear regression, linear discriminant analysis (LDA), Principal Component Analysis (PCA), Independent Component Analysis (ICA). Kernal linear discriminant analysis (KLDA).					
Module 3	Kernel methods,	Assignment/mini project	Programing / simulation	**14** *Sessions*	

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	Computational algorithms			

Topics:
Kernel methods: Dual representations-Constructing kernels, K- means Algorithm, Fuzzy K- means Algorithm, Kohonen Self organizing Maps, Maximum margin classifier (Support Vector Machine), Particle swarm optimization--Ant colony optimization- Bacterial foraging. Genetic algorithm.

List of Laboratory Tasks: Nil

Targeted Application & Tools that can be used:

Targeted Applications: This course is contributed for placement in data science companies, research & development work and also useful to know the existing & developing Artificial Intelligence.

Professionally Used Software: MatLab, Phython

Text Books:

1. Pattern recognition and machine learning, Christopher M. Bishop, TMH, Springer, 2010
2. Algorithm Collections for Digital Signal Processing Applications Using Matlab, E.S. Gopi, Springer.

Reference(s):

Reference Books

1. Machine Learning and Artificial Intelligence, Ameet V Joshi, Springer, 2020.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://youtube.com/playlist?list=PL1xHD4vteKYVpaIiy295pg6_SY5qznc77
2. https://archive.ics.uci.edu/ml/index.php

3.https://presiuniv.knimbus.com/user#/home

E-content:

1. Mengyuan Zhu, Jiawei Wang, Xiao Yang, Yu Zhang, Linyu Zhang, Hongqiang Ren, Bing Wu, Lin Ye, A review of the application of machine learning in water quality evaluation, Eco-Environment & Health, 2022, ISSN 2772-9850, https://doi.org/10.1016/j.eehl.2022.06.001.

2. Lin Li, Yici Cai, Qiang Zhou, A survey on machine learning-based routing for VLSI physical design, Integration, Volume 86, 2022, Pages 51-56, ISSN 0167-9260, https://doi.org/10.1016/j.vlsi.2022.05.003.

3. Vijaya B. Kolachalama, Machine learning and pre-medical education, Artificial Intelligence in Medicine, Volume 129, 2022, 102313, ISSN 0933-3657, https://doi.org/10.1016/j.artmed.2022.102313.

4. Sergio Ledesma, Mario-Alberto Ibarra-Manzano, Dora-Luz Almanza-Ojeda, Juan Gabriel Avina-Cervantes, Eduardo Cabal-Yepez, On removing conflicts for machine learning, Expert Systems with Applications, Volume 206, 2022, 117835, ISSN 0957-4174, https://doi.org/10.1016/j.eswa.2022.117835

Topics relevant to "EMPLOYABILITY SKILLS": Artificial Neural Networks, Learning Algorithms, linear regression for developing **Employability Skills** through **Problem Solving methodologies**. This is attained through assessment component mentioned in course handout.

Catalogue prepared by	Mr. G Tirumala Vasu
Recommended by the Board of Studies on	**BOS Meeting NO: 15th, Dated BOS 28/07/2022**

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Date of Approval by the Academic Council	**Academic Council Meeting No. 18th, Dated 03/08/2022**

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A-2 [2022] COURSE HAND OUT

SCHOOL	**:** SOE
DEPT.	**:** ECE
DATE OF ISSUE	**:** 27/08/2022
NAME OF THE PROGRAM	**:** B. Tech (ECE)
P.R.C. APPROVAL REF.	**: PU/AC-18.4/ECE15/ECE/2022-24**
SEMESTER/YEAR	**:**
COURSE TITLE & CODE	**:** Computational Intelligence and Machine Learning & ECE 3020
COURSE CREDIT STRUCTURE	**:** 3-0-3
CONTACT HOURS	**: 3**
COURSE INSTRUCTORS	**:** Mr. G. Tirumala Vasu
INSTRUCTOR INCHARGE	**:** Mr. G. Tirumala Vasu

PROGRAM OUTCOMES:

Graduates of the B. Tech. Program in Electronics and Communication Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES: Basic concepts of matrix operations, probability theory, vector and array representation. etc.,

COURSE DESCRIPTION: The course aims to make the students to understand the mathematical approaches for machine learning and computational intelligence algorithms. This course covers the basic concepts of Neural Networks which will enable the students to understand the concepts of machine learning. Concepts of Linear models for regression and classification will be discussed in such way that students can able to perform data analysis in practical applications. In this course, Computational intelligence algorithms are included to get better understanding of Artificial intelligence.

COURSE OBJECTIVES: The objective of the course is to familiarize the learners with the concepts of Computational Intelligence and Machine Learning and attain EMPLOYABILITY SKILLS through PROBLEM SOLVING.

COURSE OUTCOMES:

On successful completion of the course the students shall be able to:

CO1: Analyze the fundamental concepts of neural networks

CO2: Implement ML algorithms to regression, classification, clustering, and dimensionality reduction

CO3: Categorize the various pattern recognition techniques using machine learning into supervised and unsupervised.

MAPPING OF C.O. WITH P.O.

[H-HIGH, M- MODERATE, L-LOW]

PO / CO	1	2	4	5	6	12

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1	H				L	
2	H		M	M		M
3	H	M		H		

COURSE CONTENT (SYLLABUS):

Module: 1: Linear Models for Regression: Introduction, Linear Basis Function Models, Maximum likelihood and least squares, Geometry of least squares, Sequential learning, Regularized least squares. The Bias-Variance Decomposition, Introduction to Recurrent Neural networks. **[12 hours] [Knowledge]**

Module: 2: Linear Models For Classification: Introduction, Discriminant Functions- Two classes, Multiple classes, Least squares for classification, LDA, KLDA, PCA, The perceptron algorithm, Probabilistic Discriminative Models- Logistic regression, Iterative reweighted least squares.

[13 hours] [Application]

Module 3: Clustering: K-Means, Fuzzy K-Means algorithms. Self-Organizing Maps. Optimization Algorithms: Introduction, Particle swarm optimization-Genetic algorithm-Ant colony optimization- Bacterial foroging

. **[10 hours] [Comprehension]**

SKILL SETS TO BE DEVLOPED:

1. An attitude of enquiry.
2. Confidence and ability to tackle new problems.
3. Ability to interpret events and results.
4. Write reports.
5. The ability to follow standard /Legal procedures.
6. An awareness of the Professional Ethics.

DELIVERY PROCEDURE (PEDAGOGY): Lectures will be conducted with aid of Microsoft Teams. Assignments based on course contents will be given to the students at the end of each unit/topic and will be evaluated at regular interval.

SELF-LEARNING TOPICS: Sequential models: Markov model, Hidden-Markov Model (HMM). Linear Dynamical Systems (LDS).

BLENDED LEARNING USING VIDEOS: PCA and SVM Classification.

FLIPPED CLASS ROOM TOPICS: Maximum likelihood and least squares.

REFERENCE MATERIALS: Textbooks, reference books, any other resources, like webpages.

Text Book(s):

(i) Text Books:

1. Pattern recognition and machine learning, Christopher M. Bishop, TMH, Springer, 2010
2. Algorithm Collections for Digital Signal Processing Applications Using Matlab, E.S. Gopi, Springer.

(ii) Reference book:

1. Machine Learning and Artificial Intelligence, Ameet V Joshi, Springer, 2020.

(iii) Class Notes:

(iv) E-content:

1. Mengyuan Zhu, Jiawei Wang, Xiao Yang, Yu Zhang, Linyu Zhang, Hongqiang Ren, Bing Wu, Lin Ye, A review of the application of machine learning in water quality evaluation, Eco-Environment & Health, 2022, ISSN 2772-9850, https://doi.org/10.1016/j.eehl.2022.06.001.

2. Lin Li, Yici Cai, Qiang Zhou, A survey on machine learning-based routing for VLSI physical design, Integration, Volume 86, 2022, Pages 51-56, ISSN 0167-9260, https://doi.org/10.1016/j.vlsi.2022.05.003.

3. Vijaya B. Kolachalama, Machine learning and pre-medical education, Artificial Intelligence in Medicine, Volume 129, 2022, 102313, ISSN 0933-3657, https://doi.org/10.1016/j.artmed.2022.102313.

4. Sergio Ledesma, Mario-Alberto Ibarra-Manzano, Dora-Luz Almanza-Ojeda, Juan Gabriel Avina-Cervantes, Eduardo Cabal-Yepez, On removing conflicts for machine learning, Expert Systems with Applications, Volume 206, 2022, 117835, ISSN 0957-4174, https://doi.org/10.1016/j.eswa.2022.117835.

GUIDELINES TO STUDENTS:

Students have to attend classes regularly and follow the session very carefully. Here in handout we mentioned pre requisitions, go through the topics once. The students are directed to maintain separate note book to write important discussions/key points during the lecture

PRESIDENCY UNIVERSITY LIBRARY LINK: https://presiuniv.knimbus.com/user#/home

COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
1.	Over View of the course			01
2.	Module : 01			12
3.	Module 01 revision			1
4.	Assignment 1			---
5.	Module : 02			13
6.	Module 02 revision			1
7.	Mid Term Examination			NA
8.	Mid Term Paper Discussion			03
9.	Module:03			10

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8	Assignment 2			---
9	End Term Examination			NA
			TOTAL	41

SCHEDULE OF INSTRUCTION

Sl. No	Session No/ Date*	Lesson Title	Topics	CO. NO	Delivery Mode	Reference
1	L1		Overview of the course		Board/PPT	NA
2	L2	Course and Program Integration			Board/PPT	NA
3	L3	Linear Models for Regression	Introduction	CO1	Board/PPT	T1
4	L4		Linear Basis Function Models	CO1	Board/PPT	T1
5	L5		Linear Basis Function Models	CO1	Board/PPT	T1
6	L6		Maximum likelihood and least squares	CO1	Board/PPT	T1
7	L7		Maximum likelihood and least squares	CO1	Board/PPT	T1
8	L8		Geometry of least squares	CO1	Board/PPT	T1
9	L9		Sequential learning	CO1	Board/PPT	T1
10	L10		Sequential learning	CO1	Board/PPT	T1
11	L11		Regularized least squares	CO1	Board/PPT	T1
12	L12	Bias-Variance	The Bias-Variance Decomposition	CO1	Board/PPT	T1
13	L13		Test-1 discussion and Module-1 Revision	CO1	Board/PPT	T1
14	L14	Bias-Variance	The Bias-Variance Decomposition	CO1	Board/PPT	T1
15	L15		Bayesian Linear	CO1	Board/PPT	T1

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			Regression			
Module 1 completed , Module 2 Started						
16	L16	Linear Models For Classification	Introduction	CO2	Board/PPT	T1
17	L17	Discriminant Functions	Discriminant Functions- Two classes	CO2	Board/PPT	T1
18	L18		Multiple classes	CO2	Board/PPT	T1
19	L19		Least squares for classification	CO2	Board/PPT	T1
20	L20		Least squares for classification	CO2	Board/PPT	T1
21	L21	Dimensionality Reduction	LDA	CO2	Board/PPT	T1
22	L22		LDA	CO2	Board/PPT	T1
23	L23		PCA	CO2	Board/PPT	T1
24	L24		PCA	CO2	Board/PPT	T1
25	L25		The perceptron algorithm	CO2	Board/PPT	T1
26	L26	Probabilistic Discriminative Models	Logistic regression	CO2	Board/PPT	T1
27	L27		Logistic regression	CO2	Board/PPT	T1
28	L28		Iterative reweighted least squares	CO2	Board/PPT	T1
29	L29	Revision	Module -2 Revision	CO2	Board/PPT	T1
30	L30	**Clustering**	K-Means algorithm	CO3	Board/PPT	T1,T2
31	L31		K-Means algorithm	CO3	Board/PPT	T1,T2
32	L32		Fuzzy K-Means algorithm	CO3	Board/PPT	T1,T2
33	L33		Test-2 Discussion	CO3	Board/PPT	T1,T2
34	L34	**Optimization Algorithms**	Self-Organizing Map	CO3	Board/PPT	T1,T2
35	L35		Particle swarm optimization	CO3	Board/PPT	T1,T2
36	L36		Particle swarm optimization	CO3	Board/PPT	T1,T2

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37	L37		Ant colony optimization	CO3	Board/PPT	T1,T2
38	L38		Ant colony optimization	CO3	Board/PPT	T1,T2
39	L39		Numerical problems	CO3	Board/PPT	T1,T2
40	L40		Numerical problems	CO3	Board/PPT	T1,T2
41	L41		Module -3 Revision	CO3	Board/PPT	T1,T2

* These dates are only indicative - applicable to one section handled by subject IC. Dates will vary from section to section.

Topics relevant to "EMPLOYABILITY SKILLS": Artificial Neural Networks, Learning Algorithms, linear regression for developing **Employability Skills** through **Problem Solving methodologies**. This is attained through the **Assignment** as mentioned in the assessment component.

ASSESSMENT SCHEDULE:

Sl. No	**Assessment type**	**Contents**	**CO. NO**	**Duration In Minutes**	**Marks**	**Weightage**	**Venue, DATE &TIME**
1.	Mid Term	Module 1,2	CO1,CO2	90 min	60	30%	
2.	End term Examination	Module 1,2,3	CO1,CO2,CO3	180 min	100	50%	
3.	Assignment	-	CO1,CO2,CO3	NA	20	10%	
4.	Assignment		CO1, CO2, CO3	NA	10	5%	
5.	Assignment-Review of digital / e-resources from Pres. Univ. link given in the References Section - (Mandatory to submit	1.https://ieeexplore.ieee.org/document/9670709 2.https://ieeexplore.ieee.org/document/9676634 3.https://ieeexplore.ieee.org/document/9691296 4.https://ieeexplore.ieee.org/document/97	CO1,CO2,CO3	NA	10	5%	Will be announced one week prior to submission

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	screenshot accessing digital resource. Otherwise it will not be evaluated)	93641					

COURSE CLEARANCE CRITERIA: A minimum of 75% attendance is required to attend the end term exam. Make-up policy will be only as per academic regulation. There will be no make-up for ASSIGNMENT and QUIZ

Method of Assessment for Courses with Credit Structure (L –T – 0) or (L – 0 – 0)			
	Components of Continuous Assessments	**Weightage (% of Total Marks)**	**Duration of Assessment**
1.	Mid Term	30%	1.5 hour
2.	This Component of continuous assessment shall consist of at least TWO (02) of the following: (1) Assignment(s) (2) Quiz	20%	NA
3.	End Term Final Examinations	50%	3 hours
	Total	**100%**	

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS: It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

SAMPLE THOUGHT PROVOKING QUESTIONS:

SL NO	**QUESTION**	**MARKS**	**CO. NO**	**BLOOM'S LEVEL**
1	Explain how sequential learning is more benefited than Maximum likelihood estimation.	10	1	Comprehension
2	Why can't simple random sampling of training data set and validation set work for a classification problem	5	2	Comprehension

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3	How computational algorithms are more effective than natural algorithms.	10	3	Application

Target set for course Outcome attainment:

Sl. No	CO. No.	Course Outcomes	Target set for attainment in percentage
1	CO1	Describe the fundamental concepts of neural networks	50%
2	CO2	Apply ML algorithms to regression, classification, clustering, and dimensionality reduction	40%
3	CO3	Discuss various computational intelligence techniques	50%

Signature of the course Instructor:

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks
1	Midterm Examination			
3	End term Examination			
4	Mini Project / Assignment			

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Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment &Measures to enhance the attainment
01	CO1	Analyze and formulate fundamental concepts of neural networks	50%		
02	CO2	Implement, customize and apply ML algorithms to regression, classification, clustering, and dimensionality reduction	40%		
03	CO3	Summarize various computational intelligence techniques.	50%		

Name and signature of the Faculty member:

D.A.C. observation and approval:

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret,	applying knowledge to actual situations

	manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY

Private University Estd. in Karnataka State by Act No. 41 of 2013

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Year: 2022-2023 (ODD) **Semester: V** **Section: 5ECE3**

Course Title : Computational Intelligence and Machine Learning

Course Code : ECE3020

Type of Skill : Employability Skills

Type of Activity : Problem Solving

Instructor in Charge : Mr. G.Tirumala Vasu

Instructor for Section : Mr. G.Tirumala Vasu

Details about the activity : Students were asked to submit assignment

Assignment (Instruction to Students)

1. Students are supposed to upload the following documents in single folder. **Folder name** should be your roll numbers (eg 20201ECE0149)
    a. PPT
    b. Printable document in PDF,
    c. Data set (Link given in xlsx sheet)
2. PPT should include **data description** and **analysis the data** with PCA and SVM
3. While doing data analysis, **screenshot** of MATLAB (or other tool that you used) to be include in PPT.
4. Student Batches details and Data set links are mentioned in attachement.
5. If any report not follow the above instructions their reports should **not be evaluated**.

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Presidency University, Bengaluru

School of Engineering

5ECE3-CIML

Mini Project

S.No.	ID NO	STUDENT NAME	Data set Link
1	20201ECE0131	DANDUPROLU HEMANTH KUMAR	https://archive.ics.uci.edu/ml/datasets/Abalone
2	20201ECE0133	ROKKAM ANUDEEP REDDY	https://archive.ics.uci.edu/ml/datasets/LED+Display+Domain
3	20201ECE0134	J CALVIN KENNETH ANTHONY	https://archive.ics.uci.edu/ml/datasets/Arrhythmia
4	20201ECE0135	MACHA HARISH	https://archive.ics.uci.edu/ml/datasets/Glass+Identification
5	20201ECE0137	B SAI MADHURI	https://archive.ics.uci.edu/ml/datasets/MONK%27s+Problems
6	20201ECE0141	KETHAN DURGA AKASH	https://archive.ics.uci.edu/ml/datasets/Audiology+%28Original%29
7	20201ECE0146	Y PREETHI	https://archive.ics.uci.edu/ml/datasets/Optical+Recognition+of+Handwritten+Digits
8	20201ECE0147	KUNDA GANESH	https://archive.ics.uci.edu/ml/datasets/Japanese+Credit+Screening
9	20201ECE0149	PRAVEEN S	https://archive.ics.uci.edu/ml/datasets/Shuttle+Landing+Control
10	20201ECE0150	DEEPAK KARALAPATI	https://archive.ics.uci.edu/ml/datasets/Credit+Approval
11	20201ECE0151	SNEHAN THEJASWI T	https://archive.ics.uci.edu/ml/datasets/Echocardiogram
12	20201ECE0155	NISCHITHA V	https://archive.ics.uci.edu/ml/datasets/SPECTF+Heart
13	20201ECE0156	K SHIVA RAMA KRISHNA	https://archive.ics.uci.edu/ml/datasets/Internet+Advertisements
14	20201ECE0157	B BHAVANI SANKAR	https://archive.ics.uci.edu/ml/datasets/CMU+Face+Images
15	20201ECE0158	RAMDAS T R	https://archive.ics.uci.edu/ml/datasets/Adult
16	20201ECE0159	SUCHISMITA BANIK	https://archive.ics.uci.edu/ml/datasets/Lung+Cancer
17	20201ECE0160	J ABHINAV REDDY	https://archive.ics.uci.edu/ml/datasets/Low+Resolution+Spectrometer
18	20201ECE0163	ABHIJEET S P	https://archive.ics.uci.edu/ml/datasets/Badges
19	20201ECE0164	ADARSH	https://archive.ics.uci.edu/ml/datasets/Lenses
20	20201ECE0165	ANUPAMA KUMARI P	https://archive.ics.uci.edu/ml/datasets/Connect-4
21	20201ECE0166	ANUSHA N	https://archive.ics.uci.edu/ml/datasets/Primary+Tumor
22	20201ECE0167	ARPITHA M P	https://archive.ics.uci.edu/ml/datasets/Heart+Disease
23	20201ECE0168	AYUSH KUMAR	https://archive.ics.uci.edu/ml/datasets/Haberman%27s+Survival
24	20201ECE0169	BALU P	https://archive.ics.uci.edu/ml/datasets/Artificial+Characters
25	20201ECE0170	BHARATH M	https://archive.ics.uci.edu/ml/datasets/Mechanical+Analysis
26	20201ECE0174	CHATHRUSH MADDINENI	https://archive.ics.uci.edu/ml/datasets/Mushroom
27	20201ECE0175	CLEVEN B	https://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+%28Original%29
28	20201ECE0176	DHANYA S	https://archive.ics.uci.edu/ml/datasets/Balance+Scale
29	20201ECE0177	DHARSHAN.D	https://archive.ics.uci.edu/ml/datasets/Dermatology
30	20201ECE0178	ESHWAR ANIL KUMAR DADGE	https://archive.ics.uci.edu/ml/datasets/Page+Blocks+Classification

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31	20201ECE0179	JEEVAN N	https://archive.ics.uci.edu/ml/datasets/Annealing
32	20201ECE0180	K.RAGHAVENDRA	https://archive.ics.uci.edu/ml/datasets/Trains
33	20201ECE0182	KEERTHAN T	https://archive.ics.uci.edu/ml/datasets/Nursery
34	20201ECE0183	KESHAV MURTHY M	https://archive.ics.uci.edu/ml/datasets/Audiology+%28Standardized%29
35	20201ECE0184	KRUTHIK G	https://archive.ics.uci.edu/ml/datasets/Congressional+Voting+Records
36	20201ECE0185	MANOJ KUMAR H V	https://archive.ics.uci.edu/ml/datasets/Robot+Execution+Failures
37	20201ECE0186	MANSOOR PASHA	https://archive.ics.uci.edu/ml/datasets/Pittsburgh+Bridges
38	20201ECE0188	N P SAKAMBARI	https://archive.ics.uci.edu/ml/datasets/Poker+Hand
39	20201ECE0189	NAMITHA K	https://archive.ics.uci.edu/ml/datasets/Hepatitis
40	20201ECE0190	NITIN HALEMANI	https://archive.ics.uci.edu/ml/datasets/Waveform+Database+Generator+%28Version+2%29
41	20201ECE0191	NOOR UL HUDA	https://archive.ics.uci.edu/ml/datasets/Balloons
42	20201ECE0192	PRASHANTH N	https://archive.ics.uci.edu/ml/datasets/Gisette
43	20201ECE0193	PRITHAM ASHOK RUDRAPUR	https://archive.ics.uci.edu/ml/datasets/Ecoli
44	20201ECE0194	PUNEETHA A	https://archive.ics.uci.edu/ml/datasets/Chess+%28King-Rook+vs.+King-Knight%29
45	20201ECE0195	R SHIVANI	https://archive.ics.uci.edu/ml/datasets/University
46	20201ECE0196	RAHUL	https://archive.ics.uci.edu/ml/datasets/Car+Evaluation
47	20201ECE0197	ROHAN S	https://archive.ics.uci.edu/ml/datasets/Image+Segmentation
48	20201ECE0198	SAJULIN JOHANAN	https://archive.ics.uci.edu/ml/datasets/Volcanoes+on+Venus+-+JARtool+experiment
49	20201ECE0199	SHASHANK GANAPATI NAIK	https://archive.ics.uci.edu/ml/datasets/Cylinder+Bands
50	20201ECE0200	SHASHANK N	https://archive.ics.uci.edu/ml/datasets/Yeast
51	20201ECE0202	TEJASWINI HD	https://archive.ics.uci.edu/ml/datasets/Parkinsons
52	20211LEC0018	HARSHA A C	https://archive.ics.uci.edu/ml/datasets/Census+Income
53	20211LEC0019	SHASHI KUMAR P	https://archive.ics.uci.edu/ml/datasets/Statlog+%28Vehicle+Silhouettes%29
54	20211LEC0020	MAHESH	https://archive.ics.uci.edu/ml/datasets/Iris
55	20211LEC0021	NAGENDRA B D	https://archive.ics.uci.edu/ml/datasets/Australian+Sign+Language+signs
56	20211LEC0022	MANOJ N	https://archive.ics.uci.edu/ml/datasets/Chess+%28King-Rook+vs.+King%29
57	20211LEC0023	YUVARAJ H	https://archive.ics.uci.edu/ml/datasets/ISOLET
58	20211LEC0024	ATISHAY PANDEY	https://archive.ics.uci.edu/ml/datasets/Flags
59	20211LEC0025	SUMITH SAMUEL H	https://archive.ics.uci.edu/ml/datasets/Covertype

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Established under Section 2(f) of UGC Act, 1956 | Presidency University Act, 2013 of the Karnataka Act No. 41 of 2013
Approved by AICTE, New Delhi

SCHOOL OF ENGINEERING

B TECH

Course code: ECE 3020

Course Name: COMPUTATIONAL INTELLIGENCE AND MACHINE LEARNING

Topic: The Monk's Problems

Faculty In-charge: Tirumala vasu

Student Name: Gaganashree S

Roll No: 20201ECE0209

Class: 5ECE4

DATA DESCRIPTION

The MONK's problem were the basis of a first international comparison of learning algorithms.

The result of this comparison is summarized in "The MONK's Problems - A Performance Comparison of Different Learning algorithms" by S.B. Thrun, J. Bala, E. Bloedorn, I. Bratko, B. Cestnik, J. Cheng, K. De Jong, has been published as Technical Report CS-CMU-91-197, Carnegie Mellon University in Dec 1991.

- One significant characteristic of this comparison is that it was performed by a collection of researchers, each of whom was an advocate of the technique they tested (often they were the creators of the various methods).
- In this sense, the results are less biased than in comparisons performed by a single person advocating a specific learning method, and more accurately reflect the generalization behavior of the learning techniques as applied by knowledgeable users.
- There are three MONK's problems. The domains for all MONK's problems are the same (described below). One of the MONK's problems has noise added. For each problem, the domain has been partitioned into a train and test set.

DATASET INFORMATION

- Number of Instances: 432
- Number of Attributes: 8 (including class attribute)
- Attribute information:

  1. class: 0, 1
  2. a1: 1, 2, 3
  3. a2: 1, 2, 3
  4. a3: 1, 2
  5. a4: 1, 2, 3
  6. a5: 1, 2, 3, 4
  7. a6: 1, 2
  8. Id: (A unique symbol for each instance)

- Missing Attribute Values: None
- Target Concepts associated to the MONK's problem:

  MONK-1: (a1 = a2) or (a5 = 1)

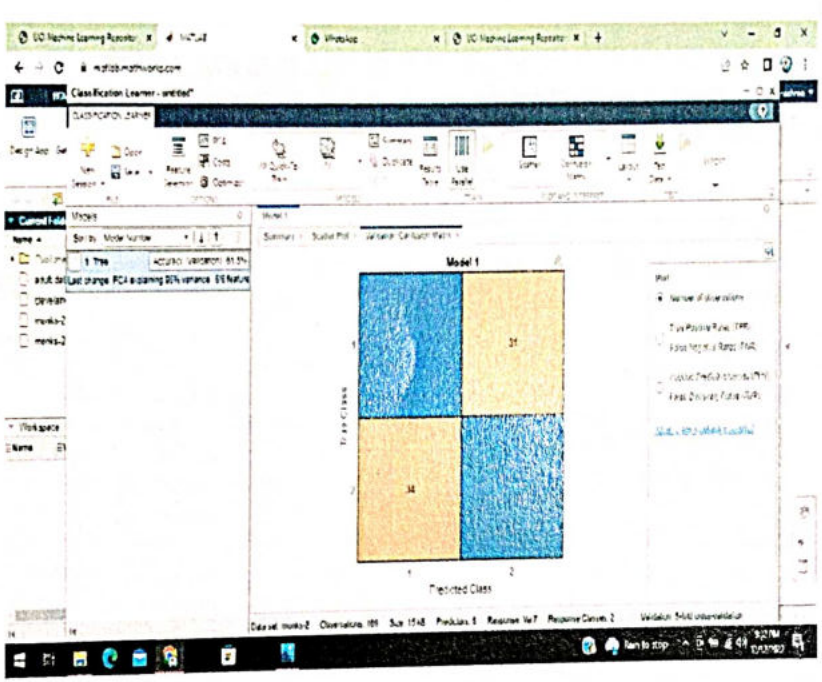
  MONK-2: EXACTLY TWO of {a1 = 1, a2 = 1, a3 = 1, a4 = 1, a5 = 1, a6 = 1}

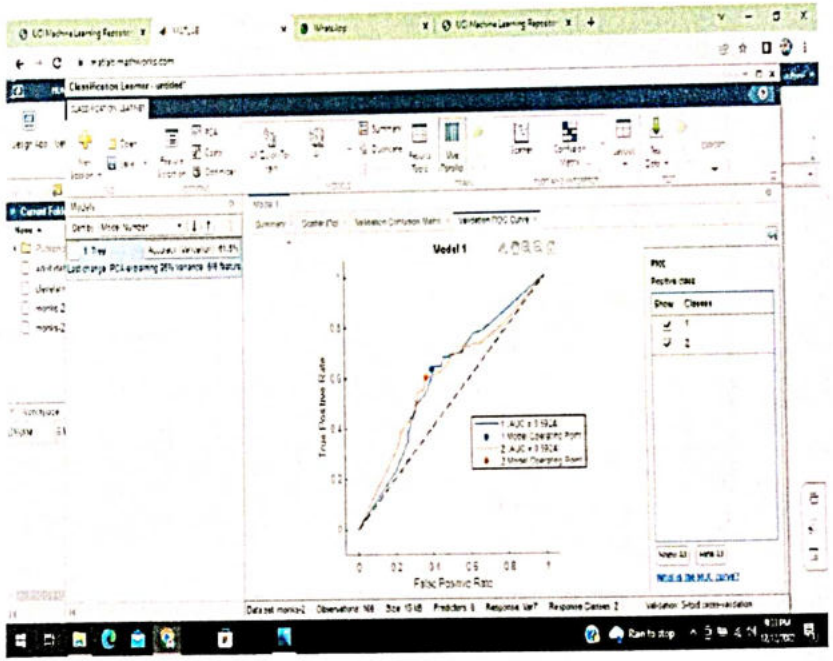
  MONK-3: (a5 = 3 and a4 = 1) or (a5 /= 4 and a2 /= 3)

  (5% class noise added to the training set)

PCA IS ENABLED

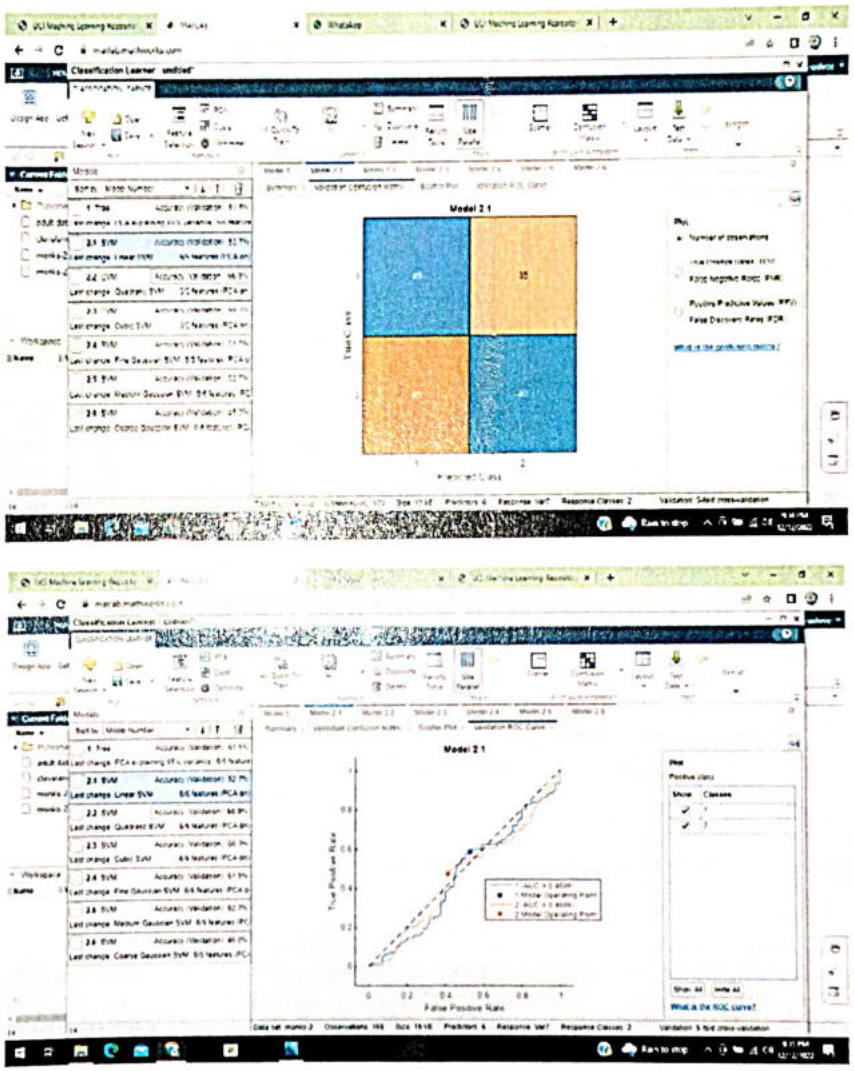
VALIDATION CONFUSION MATRIX AND VALIDATION ROC CURVE





LINEAR SVM

VALIDATION CONFUSION MATRIX AND VALIDATION ROC CURVE



CONCLUSION

We can conclude that SVM is better then PCA, as the accuracy of SVM is higher than that of PCA.

The size of given data was 7*432.

The time taken for training each model of classification varies with the Number of Attributes and Number of Instances.

The accuracy increases with more number of attributes and instances.

Missing attributes and null values must be removed and data must be cleaned before applying any model for classification.

Matlab is a easily accessible platform to analyse a dataset.

Course Code: ECE3112	**Course Title: Antenna and Microwave Engineering** **Type of Course: Program Core Theory**	**L- P- C**	3	0	3
Version No.	1.0				
Course Pre-requisites	Basic concepts of Cartesian, cylindrical and spherical coordinate systems. Differential length (dl), surface (ds) and volume (dv). Line, surface and volume integrals. Divergence and curl operations. Fundamentals of static electric and magnetic fields which includes electric field density and intensity, magnetic field density and intensity, Maxwell's equations, boundary conditions.				
Anti-requisites	**NIL**				
Course Description	This course will introduce the basics of electromagnetic radiation and propagation and also deals with how VHF and UHF antennas are used in microwave communication. This course gives a comprehensive coverage of a wide variety of antennas and propagation techniques related to numerous communication systems. This course provides an opportunity to validate the concepts of mathematical modeling behind the antenna design.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of **Antenna and Microwave Engineering** and attain **SKILL DEVELOPMENT** through **Problem Solving techniques.**				
Course Outcomes	**On successful completion of the course the students shall be able to:** 1. **Summarize** the fundamental parameters and Radiation Pattern of Different Types of Antennas. 2. **Discuss** the working and design of VHF, UHF and Microwave Antennas 3. **Analysis** of how the electromagnetic wave is propagates in different atmospheric conditions as a ground, space, sky wave.				
Course Content:					
Module 1	Fundamentals of Antenna parameters	Assignment	Memory Recall based Quizzes	**10 *Sessions***	
Topics: Introduction, Basic radiation Equation, Radiation Pattern., Beam Area, Beam Efficiency, Radiation Power density, Field Regions, Radiation Intensity, Directivity and Gain Bandwidth, Antenna Apertures, Front to back ratio, Friis Transmission formula, Antenna Theorems.					
Module 2	Basic antenna Design	Assignment / Quiz	Design and analysis of parameters (simulation)	**11 *Sessions***	
Topics: Long wire And V antennas, Rhombic Antenna, Folded Dipole Antenna, Yagi Uda Antenna, Helical Antenna, and Horn Antennas. Micro strip Antennas, Reflector Antennas, Cassegrain Antenna, Feed methods of Parabolic Reflectors, Frequency independent Antennas.					
Module 3	Wave Propagation	Assignment	Memory Recall based Quizzes	**12 *Sessions***	
Topics: Wave Propagation- Introduction, Ground wave Propagation, Classification of Electromagnetic Waves, Reflection of Radio waves by earth surface. Space wave Propagation- considerations, Tropospheric propagation,					

Sky wave propagation- structure of ionosphere, Propagation of radio waves through ionosphere. Mechanism of wave bending and critical frequency. MUF, skip distance, Relation between MUF and skip distance.

Module 4	Passive and active microwave devices	Assignment	Memory Recall based Quizzes	**12 *Sessions***

Topics

Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, attenuator, resonator, Principles of Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes, Microwave tubes: Klystron, TWT, Magnetron. Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design.

Targeted Application & Tools that can be used:

This course is contributed for placement in core companies, research & development work and also useful to know the existing & developing communications.
Professionally Used Software: MATLAB, HFSS.

Text Books:

1. Antennas and wave propagation – John D. Kraus and Ronald J. Marhefka and Ahmad S.Khan, TMH, New Delhi, 5th Ed., (special Indian Edition), 2017

2. Antenna Analysis and Design , Constantine A. Balanis, Wiley Publications, 4th Ed, 2016.

Reference Books:

1. Antenna Theory and Design, Warren L. Stutzman, Gary A. Thiele, Wiley Publications, 3rd Edition.

2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd ed., 2000.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://youtube.com/playlist?list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMZT
2. https://www.sciencedirect.com/topics/engineering/radio-wave
3. https://www.sciencedirect.com/topics/physics-and-astronomy/wave-propagation
4. https://presiuniv.knimbus.com/user#/home

E-content:

1. Zhe Chen, Xiao-Ting Yuan, Jian Ren, Tao Yuan, An ultra-wideband MIMO antenna for 5G smartphone, AEU - International Journal of Electronics and Communications, Volume 154, 2022, 154301, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2022.154301.

2. Jian Ren, Zheng-Yu Xiong, Jing-Ya Deng, Jia-Yuan Yin, Yin Zhang, Li-Xin Guo, A compact single-layer filtering patch antenna with wide harmonic suppression and enhanced bandwidth, AEU - International Journal of Electronics and Communications, Volume 145, 2022, 154083, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2021.154083.

3. Jian Ren, Zheng-Yu Xiong, Jing-Ya Deng, Jia-Yuan Yin, Yin Zhang, Li-Xin Guo, A compact single-layer filtering patch antenna with wide harmonic suppression and enhanced bandwidth, AEU - International Journal of Electronics and Communications, Volume 145, 2022, 154083, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2021.154083.

4. Xiaokun Yang, Linwei Cui, Zhao Ding, Zhengping Zhang, A 5G filtering antenna simultaneously featuring high selectivity and band notch, AEU - International Journal of Electronics and Communications, Volume 153,
2022, 154299, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2022.154299.

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Topics relevant to "SKILL DEVELOPMENT": , Basic radiation Equation, Radiation Pattern., Beam Area, Beam Efficiency, Radiation Power density, Field Regions, Radiation Intensity, Directivity and Gain Bandwidth, Antenna Apertures, Front to back ratio, Friis Transmission formula, Antenna Theorems, Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, attenuator, resonator, Principles of Microwave,, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design **for Skill Development through Problem Solving methodologies. This is attained through assessment component mentioned in course handout.**	
Catalogue prepared by	Dr Rakesh
Recommended by the Board of Studies on	15th BOS held on 28/07/2022
Date of Approval by the Academic Council	Meeting No. 18th , Dated 03/08/2022

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A-2 [2022] COURSE HAND OUT

SCHOOL: School of Engineering **DEPT.:** ECE **DATE OF ISSUE:** 28/07/2020

NAME OF THE PROGRAM : B.Tech.

P.R.C. APPROVAL REF. : PU/AC-11/8/06_2020

SEMESTER/YEAR : 5TH SEM / 3RD YEAR

COURSE TITLE & CODE : **Antenna and microwave engineering & ECE3112**

COURSE CREDIT STRUCTURE : 4 Credits

CONTACT HOURS : 4 hours per week

INSTRUCTOR INCHARGE : Mr. Tirumala Vasu G

COURSE INSTRUCTOR : Mr. Tirumala Vasu G

PROGRAM OUTCOMES:

Graduates of the B. Tech. Program in Electronics and Communication Engineering will be able to:

Legend: Bold indicates this PO is covered by some COs of this particular course Normal font indicates PO is not covered under this course COs

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem Analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern Tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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.

COURSE PREREQUISITES: Basic concepts of Cartesian, cylindrical and spherical coordinate systems. Differential length (dl), surface (ds) and volume (dv). Line, surface and volume integrals. Divergence and curl operations. Fundamentals of static electric and magnetic fields which includes electric field density and intensity, magnetic field density and intensity, Maxwell's equations, boundary conditions.

COURSE OBJECTIVE: The objective of the course is to familiarize the learners with the concepts of Antenna and Microwave Engineering and attain SKILL DEVELOPMENT through Problem Solving techniques.

COURSE DESCRIPTION:

This course will introduce the basics of electromagnetic radiation and propagation and also deals with how VHF and UHF antennas are used in microwave communication. This course gives a comprehensive coverage of a wide variety of antennas and propagation techniques related to numerous communication systems. This course provides an opportunity to validate the concepts of mathematical modeling behind the antenna design.

COURSE OUTCOMES:

On successful completion of the course the students shall be able to:

CO1: Summarize the fundamental parameters and Radiation Pattern of Different Types of Antennas.

CO2: Discuss the working and design of VHF, UHF and Microwave Antennas

CO3: Analysis of how the electromagnetic wave is propagates in different atmospheric conditions as a ground, space, sky wave.

.

MAPPING OF C.O. WITH P.O. [Select only such P.O.s which are highlighted above and mark H/M/L Against each of the C.O. depending on the degree of contribution of the C.O.to the P.O.]

[H-HIGH, M- MODERATE, L-LOW]

PO CO	PO1	PO2	PO5	PO12
CO1	H	L		
CO2		H	M	
CO3	M			M

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COURSE CONTENT (SYLLABUS):

Module-1 : Fundamentals of Antenna parameters: Introduction, Basic radiation Equation, Radiation Pattern., Beam Area, Beam Efficiency, Radiation Power density, Field Regions, Radiation Intensity, Directivity and Gain Bandwidth, Antenna Apertures, Front to back ratio, Friis Transmission formula, Antenna Theorems. **[11 Hrs] [Blooms 'level selected: Knowledge]**

Module -2: Basic antenna Design Long wire And V antennas, Rhombic Antenna, Folded Dipole Antenna, Yagi Uda Antenna, Helical Antenna, and Horn Antennas. Micro strip Antennas, Reflector Antennas, Cassegrain Antenna, Feed methods of Parabolic Reflectors, Frequency independent Antennas. **[10 Hrs] [Blooms 'level selected: Comprehension]**

Module-3 Wave Propagation - Introduction, Ground wave Propagation, Classification of Electromagnetic Waves, Reflection of Radio waves by earth surface. Space wave Propagation- considerations, Tropospheric propagation, Sky wave propagation- structure of ionosphere, Propagation of radio waves through ionosphere. Mechanism of wave bending and critical frequency. MUF, skip distance, Relation between MUF and skip distance.

[12 Hrs] [Blooms 'level selected: Comprehension]

Module-4: Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, attenuator, resonator, Principles of Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes, Microwave tubes: Klystron, TWT, Magnetron. Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design

[12 Hrs] [Blooms 'level selected: Comprehension]

SKILL SETS TO BE DEVLOPED:

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. **Ability to interpret events and results.**
4. **Ability to work as a leader and as a member of a team.**
5. **Assess errors in systems/processes/programs/computations and eliminate them.**
6. **Observe and measure physical phenomena.**
7. **Write reports.**
8. **Select suitable equipment, instrument, materials & software**
9. **Locate faults in system/Processes/software.**
10. **Manipulative skills for setting and handling systems/Process/Issues**
11. **The ability to follow standard /Legal procedures.**
12. **An awareness of the Professional Ethics.**
13. **Need to observe safety/General precautions.**

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14. To judge magnitudes/Results/issues without actual measurement/actual contacts

DELIVERY PROCEDURE (PEDAGOGY): Lectures will be conducted with the aid of multi-media projector, blackboard, etc. Assignments based on course contents will be given to the students at the end of each unit/topic and will be evaluated at regular interval.

SELF-LEARNING TOPICS: Separation of Field Regions (Far field Derivation), Radiated power of Loop Antenna, Smart antennas Like Polarization Reconfigurable antenna.

Experiential Learning Topics:

Assignment 1: Designing/simulate a practical antenna (Reconfigurable antennas are preferable) from own specifications for Folded Dipole Antenna.

Assignment 2: Designing/simulate a practical antenna (Reconfigurable antennas are preferable) from own specifications for Corner Reflectors.

Assignment 3: Designing/simulate a practical antenna (Reconfigurable antennas are preferable) from own specifications Rectangular Micro strip Antennas.

REFERENCE MATERIALS: Textbooks, reference books, any other resources, like webpages.

I. Text Book(s):

1. Antennas and wave propagation – John D. Kraus and Ronald J. Marhefka and Ahmad S.Khan, TMH, New Delhi, 5th Ed., (special Indian Edition), 2017

2. Antenna Analysis and Design , Constantine A. Balanis, Wiley Publications, 4th Ed, 2016.

II. Reference book(s):

1. Antenna Theory and Design, Warren L. Stutzman, Gary A. Thiele, Wiley Publications, 3rd Edition

2. Electromagnetic Waves and Radiating Systems – E.C. Jordan and K.G. Balmain, PHI, 2nd ed., 2000.

Online Resources (e-books, notes, ppts, video lectures etc.):

1. https://youtube.com/playlist?list=PL3UZlxOnyu9CRoBFsG5x-VqYeC69FmMZT
2. https://www.sciencedirect.com/topics/engineering/radio-wave
3. https://www.sciencedirect.com/topics/physics-and-astronomy/wave-propagation

E-content:

1. Zhe Chen, Xiao-Ting Yuan, Jian Ren, Tao Yuan, An ultra-wideband MIMO antenna for 5G smartphone, AEU - International Journal of Electronics and Communications, Volume 154, 2022, 154301, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2022.154301.

2. Jian Ren, Zheng-Yu Xiong, Jing-Ya Deng, Jia-Yuan Yin, Yin Zhang, Li-Xin Guo, A compact single-layer filtering patch antenna with wide harmonic suppression and enhanced bandwidth, AEU - International Journal of Electronics and Communications, Volume 145, 2022, 154083, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2021.154083.

3. Jian Ren, Zheng-Yu Xiong, Jing-Ya Deng, Jia-Yuan Yin, Yin Zhang, Li-Xin Guo, A compact single-layer filtering patch antenna with wide harmonic suppression and enhanced bandwidth, AEU - International Journal of Electronics and Communications, Volume 145, 2022, 154083, ISSN 1434-8411, https://doi.org/10.1016/j.aeue.2021.154083.

4. Xiaokun Yang, Linwei Cui, Zhao Ding, Zhengping Zhang, A 5G filtering antenna simultaneously featuring high selectivity and band notch, AEU - International Journal of Electronics and Communications, Volume 153,2022, 154299, ISSN 1434-8411,

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https://doi.org/10.1016/j.aeue.2022.154299.

5. Presidency University Library Link:- https://presiuniv.knimbus.com/user#/home

GUIDELINES TO STUDENTS:

- The students are advised to be very much regular to the classes and sincerely attempt the learnings listed in the Pedagogical section.
- The students are advised to take down the notes legibly which serves as a firsthand information to study and revise lecture topics on day to day basis.
- The students are advised to visit the Microsoft teams on a regular basis to access the supporting materials shared by the course instructors.
- Control Systems is a problem-based course where mostly practicing the problems is very much important than reading the theory and hence for studying the concepts, any book can be followed such as mentioned in reference books or else you can download pdf notes from NPTEL.
- The students are advised to use the journals, technical magazines and other relevant materials.
- The students are advised to watch the video lectures available online to understand and review the concepts delivered in the class as well as problems assigned for self-learning topics.
- Students are required to strictly adhere to assignment deadlines.
- Students are required to actively participate in classroom discussions and other activities which is planned in the classroom**.**
- Students are required to have minimum of 75% of attendance to be eligible to attend exam

COURSE SCHEDULE:

Sl. No.	ACTIVITY	STARTING DATE	CONCLUDING DATE	TOTAL NUMBER OF PERIODS
1.	Overview of the course			
2.	Module: 01			1
3.	Module:02			7
4.	Test-1			
5.	Module:02			3
6.	Assignment/quiz			
7.	Module:03			8
8.	Test – 2			
9.	Module: 03			04

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10.	Module: 04			12
11.	Assignment/quiz			
			TOTAL	45

SCHEDULE OF INSTRUCTION

Sl. No	Session No[Date If Possible]	Lesson Title	Topics	Course Outcome Number	Delivery Mode	Reference
1.	L1		Program Integration		Offline	
2.	L2		Course Integration		Offline	
3.	L3	Fundamentals of Antenna parameters	Introduction, Basic radiation Equation	CO1	Offline	T2, R1
4.	L4		Radiation Pattern	CO1	Offline	T2, R1
5.	L5		Beam Area, Beam Efficiency	CO1	Offline	T2, R1
6.	L6		Field Regions		Offline	T2, R1
7.	L7		Radiation Intensity	CO1	Offline	T2, R1
8.	L8		Directivity and	CO1	Offline	T2, R1
9.	L9		Gain Bandwidth	CO1	Offline	T2, R1
10.	L10		Antenna Apertures	CO1	Offline	T2, R1
11.	L11		Front to back ratio	CO1	Offline	T2, R1
12.	L12		Friis Transmission formula	CO1	Offline	T2, R1
13.	L13		Antenna Theorems	CO1	Offline	T2, R1
14.	L14	Basic antenna Design	Basic antenna	CO1	Offline	T2, R1
15.	L15		Design Long wire		Offline	T2, R1
16.	L16		V antennas, Rhombic Antenna	CO2	Offline	T2, R2
17.	L17		Folded Dipole Antenna	CO2	Offline	T2, R2
18.	L18		Yagi Uda Antenna	CO2	Offline	T2, R2
19.	L19		Helical Antenna, and Horn Antennas	CO2	Offline	T2, R2
20.	L20		Micro strip Antennas, Reflector Antennas	CO2	Offline	
21.	L21		Cassegrain Antenna	CO2	Offline	T2, R2

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22.	L22		Feed methods of Parabolic Reflectors	CO2	Offline	T2, R2
23.	L23		Frequency independent Antennas	CO2	Offline	T2, R2
24.	L24	Wave Propagation	Introduction, Ground wave Propagation	CO2	Offline	T2, R2
25.	L25		Classification of Electromagnetic Waves	CO2	Offline	T2, R2
26.	L26		Reflection of Radio waves by earth surface	CO2	Offline	T2, R2
27.	L27		Space wave Propagation-considerations,	CO2	Offline	T2, R2
28.	L28		Tropospheric propagation		Offline	T2, R2
29.	L29		. Sky wave propagation- structure of ionosphere	CO3	Offline	T2,R2
30.	L30		Propagation of radio waves through ionosphere	CO3	Offline	T2,R2
31.	**L31**		Mechanism of wave bending	**CO3**	Offline	**T2,R2**
32.	L32		critical frequency	CO3	Offline	T2,R2
33.	L33		MUF	CO3	Offline	T2,R1
34.	L34		skip distance	CO3	Offline	T2,R1
35.	**L35**		Relation between MUF and skip distance.	**CO3**	Offline	**T2,R1**
36.	L36	Microwave Passive components	Directional Coupler, Power Divider, Magic Tee	CO3	Offline	T2,R1
37.	L37		attenuator, resonator	CO3	Offline	T2,R1
38.	L38		Principles of Microwave Semiconductor Devices: Gunn Diodes	CO3	Offline	T2,R1
39.	L39		IMPATT diodes, Schottky Barrier diodes	**CO3**	Offline	**T2,R1**
40.	L40		PIN diodes, Microwave tubes: Klystron, TWT, Magnetron	CO3	Offline	T2,R1
41.	L41		Impedance transformation, Impedance Matching	CO3	Offline	T2,R1
42.	L42		Microwave Filter Design, RF and Microwave Amplifier Design	CO2	Offline	T1,R1

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43.	L43		Microwave Power amplifier Design, Low Noise Amplifier	CO2	Offline	T1,R1
44.	L44		Design, Microwave Mixer Design	CO2	Offline	T1,R1
45.	L45		Microwave Oscillator Design	CO2	Offline	T2,R1

Topics relevant to "SKILL DEVELOPMENT": , Basic radiation Equation, Radiation Pattern., Beam Area, Beam Efficiency, Radiation Power density, Field Regions, Radiation Intensity, Directivity and Gain Bandwidth, Antenna Apertures, Front to back ratio, Friis Transmission formula, Antenna Theorems, Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, attenuator, resonator, Principles of Microwave,, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design **for Skill Development through Problem Solving methodologies. This is attained through the Assignment as mentioned in the assessment component.**

ASSESSMENT SCHEDULE:

Sl.No	Assessment type	contents	CO. No	Duration In Hours	Marks	Weightage	Venue, DATE &TIME
1.	Mid term	Module 1, Module 2	CO1, CO2		50	25%	
2.	End Term Examination	Module 1,2,3,4	CO2, CO3		100	50%	
3.	Assignment /Quiz	Module 1,2,3,4	CO1, CO2, CO3, CO4		40	20%	
4.	Assignment E content	https://doi.org/10.1016/j.aeue.2021.154083 . https://doi.org/10.1016/j.aeue.2021.154083 .	CO1, CO2, CO3, CO4		10	5%	-

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COURSE CLEARANCE CRITERIA: A minimum of 75% attendance is required to attend the end term exam. Make-up policy will be only as per academic regulation. There will be no make-up for ASSIGNMENT and QUIZ

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS: It will be announced in the class. Interested students may meet the Instructor In-charge during the Chamber Consultation Hour to clear doubts.

MAKEUP POLICY:

If the student misses an evaluation component, he/she may be granted a make-up. In case of an absence that is foreseen, make-up request should be personally made to the Instructor-in-Charge, well ahead of the scheduled evaluation component. Reasons for unanticipated absence that qualify a student to apply for make-up include medical emergencies or personal exigencies. In such an event, the student should contact the Instructor-in-Charge as soon as practically possible.

SAMPLE THOUGHT PROVOKING QUESTIONS:

SL NO	QUESTION	MARKS	COURSE OUTCOME NO.	BLOOM'S LEVEL
1	A hypothetical isotropic antenna with maximum diagonal dimension of 11 m radiating at 3 MHz, What will be the minimum distance from where we can calculate all types of antenna parameters.	10	CO1	Knowledge
2	A thin linear dipole of length l is placed symmetrically about the z-axis. Find the far-zone spherical electric and magnetic components radiated by the dipole whose current distribution can be approximated by (a) $I_z(z') = \{I_0\left(1+\frac{2}{l}z'\right),\ -l/2 \le z' \le 0\ I_0\left(1-\frac{2}{l}z'\right),\ 0 \le z' \le l/2$	10	CO2	Comprehension
3	A troposcatter link is established between two antennas that are separated by a ground distance of 300 km. The two antennas are located at a height of 6 m from the surface of the earth and are launching electromagnetic waves horizontally into space. Calculate the height of the scatter volume situated mid-way between the two antennas which can be used to establish the troposcatter link.	10	CO3	Comprehension
3	Find expressions for the electric surface current density on the walls of a rectangular			

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	waveguide for a TE10 mode. Why can a narrow slot be cut along the centerline of the broad wall of a rectangular waveguide without perturbing the operation of the guide? (Such a slot is often used in a slotted line for a probe to sample the standing wave field inside the guide.)	10	CO4	Comprehension

Target set for course Outcome attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage
1	CO1	Describe the fundamental parameters and Radiation Pattern of Different Types of Antennas.	50%
2	CO2	Explain the working and design of VHF, UHF and Microwave Antennas	35%
3	CO3	Outline how the electromagnetic wave is propagates in different atmospheric conditions as a ground, space, sky wave.	40%
4	CO4	Familiarize basics and fundamentals of Microwave engineering and understand the waveguide concepts.	30%

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C

Course Completion Remarks &Self-Assessment.[This has to be filled after the completion of the course]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

Sl.no.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks

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Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

Sl.no	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment &Measures to enhance the attainment
01	Co1				
02	Co2				
03	Co2				
04	Co3				
05					
06					

Name and signature of the Faculty member:

D.A.C. observation and approval:

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase,	grasping the meaning of information

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	predict, recognize, rewrite, report, restate, review, select, summarize, translate	
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

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Private University Estd. in Karnataka State by Act No. 41 of 2013

SCHOOL of ENGINEERING
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Year: 2022-2023 (ODD) **Semester: B.Tech.,(ECE)** **Section: 6ECE2**

Course Title	**:** ANTENNA AND MICROWAVE ENGINEERING
Course Code	**:** ECE3112
Type of Skill	**:** Skill Development
Type of Activity	**:** Problem Solving
Instructor in Charge	**: Dr. PRABHU T**
Instructor for Section	**: Dr. PRABHU T**
Details about the activity	**:** Students were asked to submit assignment

Assignment1

1. A broadcasting system operating at 200MHz, employing a halfwave dipole antenna having a gain of 2.15 dB. The power supplied to the transmitting antenna is 1 kW. The minimum power to be delivered to the receiving antenna is 1nW. If the distance between two antennas is 100 km. Find the minimum gain of receiving antenna.
2. An antenna has a field pattern given by E(Θ)= $\boldsymbol{Cos^2\theta}$ ***for*** $\mathbf{0 \le \theta \le \pi/2}$, Find the HPBW and Beam area.
3. The power radiated by a lossless antenna is 20 watts. The directional characteristics of the antenna are represented by the radiation intensity of $\boldsymbol{U = U_o Cos^4\theta}$, $\mathbf{(0 \le \theta \le \pi/2,\ 0 \le \phi \le 2\pi)}$. Find the below far-field parameters
   (a) Maximum power density at a distance of 100 m.
   (b) Maximum directivity

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(c) Maximum Gain and efficiency.

4. An antenna whose directivity in a particular direction is 30 dB that is excited with a 50 V power source and produces a radiation intensity of 100 Watts/steradian in the direction of maximum radiation. Find the input resistance of the antenna.
5. Consider an antenna whose HPBWs in two orthogonal planes are 28◦ and 35◦. If the antenna is operating at 450 MHz, determine its effective aperture.
6. The Friis Transmission Equation is used to calculate the power received from one antenna when transmitted from another antenna separated by some distance. Suppose you have been asked to design an antenna operating at 1 GHz with a gain of 25 dB. What power should be supplied to the transmitting antenna such that and the minimum power that is delivered to the receiving antenna is 10.8 mW. The transmitting and the receiving antenna are 1 km apart. The gain of the receiving antenna is 20 dB.
7. Draw the structure of a helical antenna and calculate the axial length of a helical antenna where the diameter of the helix is 3 cm, pitch angle is 45◦ and the number of turns is 5.
8. Design a three element Yagi-Uda antenna to operate at a frequency of 180 MHz.
   (i) Mention all the necessary equations for the dimensions of the various elements and the inter-element spacing.
   (ii) Evaluate the dimension of all the elements
9. The beam solid angle of an antenna extends between $\pi/6 \leq \theta \leq \pi$ and $\pi/4 \leq \phi \leq \pi/3$. Find the equivalent beam solid angle and maximum directivity in dB.
10. Find the number of steradian and square degrees on a spherical surface that is between $\theta=20^0$ and $\theta=40^0$ & between $\phi=30^0$ and $\phi=70^0$.

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Mohanavinash.CH
20201ECE0077

Assignment-01

1. Given,

Sol)

$f = 200\ MHz$ $\quad G_t = 2.15\ dB$ $\quad R = 100\ km$

$P_t = 1\ kW$ $\quad P_R = 1\ nW$

$$P_R = P_t \cdot G_t \cdot G_R \left(\frac{c}{4\pi R f}\right)^2$$

$$\frac{1\times10^{-9}}{1\times10^{3}\times 0.154} = G_R \left(\frac{3\times10^{8}}{4\pi\times100\times200\times10^{6}}\right)^2$$

$$G_R = \frac{6.097\times10^{-13}}{1.424\times10^{-12}}$$

$$\boxed{G_R = 0.4281}$$

$$G_t(dB) = 10\log(G_t)$$

$$\log(G_t) = \frac{2.15}{10}$$

$$G_t = 10^{\frac{2.15}{10}}$$

$$\boxed{G_t = 1.64}$$

$$G_R(dB) = 10\log(G_R)$$

$$= 10\log(0.4281)$$

$$\boxed{G_R(dB) = -3.684\ dB}$$

2. An antenna has a field pattern given by $E(\theta) = \cos^2\theta$ for $0 \le \theta \le \pi/2$. Find the HPBW and Beam area?

Sol)

Given,

$$E(\theta) = \cos^2\theta \quad \left[0 \le \theta \le \frac{\pi}{2}\right]$$

$$E(\theta) = 0.707$$

$$\cos^2\theta = 0.707$$

$$\frac{1+\cos2\theta}{2} = 0.707$$

$$\cos2\theta = 0.414.$$

$$2\theta = \cos^{-1}(0.414)$$

$$\therefore \theta = 32.77^\circ$$

WKT,

$$\cos^2\theta = \frac{1+\cos2\theta}{2}.$$

WKT,

$\therefore$ HPW $= 2\theta$

$= 2\times32.77$

$$\boxed{HPBW = 65.543}$$

Beam area

$$\Omega_A = \int_{\phi=0}^{2\pi}\int_{\theta=0}^{\pi} E(\theta)\cdot\sin\theta\cdot d\phi\cdot d\theta$$

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$$\Rightarrow \int_{\phi=0}^{2\pi}\int_{\theta=0}^{\pi/2} (\cos^2\theta)^2 . \sin\theta . d\theta . d\phi$$

let, $x = \cos\theta$.

$dx = -\sin\theta . d\theta$

if

$\theta = 0 \quad x = 1$.

$\theta = \frac{\pi}{2} \quad x = 0$

$$= \int_{\phi=0}^{2\pi} d\phi \int_{\theta=0}^{\pi/2} \underbrace{\cos^4\theta}_{x} . \underbrace{\sin\theta . d\theta}_{-dx}$$

$$= \int_{\phi=0}^{2\pi} d\phi \; -\int_{1}^{0} x^4 \, dx.$$

$$= 2\pi . \left[\frac{-x^5}{5}\right]_1^0$$

$$\Rightarrow 2\pi \left(\frac{1}{5}\right)$$

$$\therefore \Omega_A = \frac{2\pi}{5} S_R$$

3. The power radiated by a loseless antenna is 20 watt. The directional characteristics of the antenna are represented by the radiation intensity of $u = u_0 \cos^4\theta$. $(0 \le \theta \le \frac{\pi}{2}, 0 \le \phi \le 2\pi)$ Find the below far-field parameters.

a) Max power density at a distance of 100 m.

b) Max directivity.

c) Max Gain & efficiency.

SOL)

$$P_{rad} = \int_{\phi=0}^{2\pi}\int_{\theta=0}^{\pi/2} u . \sin\theta . d\theta . d\phi$$

$$= \int_{\phi=0}^{2\pi} d\phi \int_{\theta=0}^{\pi/2} u_0 \cos^4\theta . \sin\theta . d\theta.$$

let,

$x = \cos^5\theta$.

$dx = -\sin\theta . d\theta$

$\theta = 0 \quad x = 1$

$\theta = \frac{\pi}{2} \quad x = 0$

$$= 2\pi \int_{1}^{0} -u_0 x^4 . dx.$$

$$= u_0 2\pi \left[\frac{-x^5}{5}\right]_1^0$$

$\Rightarrow 2\pi \times u_0 \times \frac{1}{5}$

$$P_{rad} = \frac{2\pi u_0}{5}$$

given,

$P_r = 20\ w$

$$\frac{20 \times 5}{2\pi} = u_0$$

$\therefore u_0 = u_{max}$

$u_0 = 15.915$ watt

i)

$u_{max} = r^2 . W_{max}$

$W_{max} = \frac{15.915}{(100)^2}$ $\quad r = 100$

$W_{max} = 1.5915 \times 10^{-3}$ watt/m^2

ii)

$D_{max} = \frac{4\pi u_{max}}{P_{rad}}$

$= \frac{4\pi \times 15.915}{20}$

$D_{max} = 9.999 \simeq 10$

$D_{max}(dB) = 10 \log (9.999)$

$D_{max} = 10$ dB

iii)

$Gain = \eta D$

$= 1 \times 9.999$ dB.

$Gain = 9.999$dB

efficiency $\eta = 1$.

$\because$ it is loseless antenna

4. An antenna whose directivity in a particular direction is 30dB that is excited with a 50V power source and produces a radiation intensity of 100 watts / steradian in the direction of maximum radiation. Find the i/p resistance of the antenna?

50V)

$V_{in} = 50V$ $\quad D_d(dB) = 30$ dB

$u_{max} = 100$ watts/sr

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$D(dB) = 10 \log (D_{max})$

$\frac{30}{10} = \log (D_{max})$

$D_{max} = 10^3 \Rightarrow$ **$D_{max} = 1000$**

$D_{max} = \frac{U_{max}}{U_0}$ $\qquad P_{rad} = \frac{4\pi U_{max}}{D_{max}}$

$U_0 = \frac{100}{1000}$ $\qquad = \frac{4\pi \times 100}{1000}$

$U_0 = 0.1$ watt/sr $\qquad$ **$P_{rad} = 1.25$ watt/sr**

∴ we know that.

$V = IR \qquad P = IV$

$I = \frac{V}{R} \qquad P = \frac{V}{R} \times V.$

$\therefore P_{rad} = \frac{V_{in}^2}{R}$

$R = \frac{(50)^2}{1.256} \Rightarrow$ **$R = 1990.44\ \Omega$**

5. Consider an antenna whose HPBWs in two orthogonal planes are 28° & 35°. If antenna operating at 450 MHz determine effective aperature.

Sol)

$D = \frac{4\pi}{\Omega_A} \qquad \Omega_A = (HPBW)_\phi (HPBW)_\theta.$

$= \frac{4\pi}{28^\circ \times 35^\circ}.$

$1\,sr = 3282$

$D = \frac{4\pi}{875}. \Rightarrow \frac{41242.828}{875}$

$\therefore 4\pi \times (sr) =$

$\Rightarrow 4\pi \times 3282$

$= 41242.828$

$D = 47.134$

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$$D = \frac{4\pi A_e}{\lambda^2} \Rightarrow \boxed{A_e = \frac{D\lambda^2}{4\pi}}$$

$$\lambda = \frac{c}{f}$$

$$\lambda = \frac{3\times10^8}{450\times10^6}$$

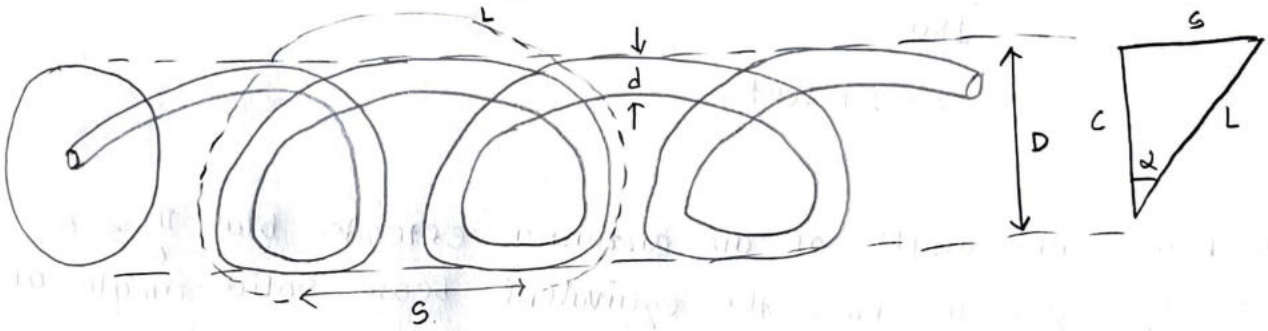
$$\boxed{\lambda = 0.666\ m}$$

$$A_e = \frac{47.134 \times (0.666)^2}{4\pi}$$

$$\boxed{A_e = 1.663}$$

7 Draw the structure of a helical antenna and calculate the axial length of helical antenna where the diameter of helix is 3cm, pitch angle is 45° & No of turns 5.

Sol)



$D = 3cm \qquad \alpha = 45° \qquad n = 5$

$$\tan\alpha = \frac{S}{C} \qquad C = \pi D$$

$$\tan(45°) = \frac{S}{\pi \times 3}$$

$$\boxed{S = 9.424\ cm}$$

$$\therefore A = nS$$

$$= 5 \times 9.424$$

$$\boxed{A = 47.12\ cm}$$

8. Design a three-element Yagi-uda antenna & calculate the ~~axial length of a helical antenna~~ operated frequency 180 MHz

i) Mention all the necessary equations for the dimensions of the various elements.

ii) Evaluate the dimensions of all the elements.

Sol)

i) Length of driven element $= \frac{475}{f(MHz)}$ feet

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*) Length of Reflector = $\frac{500}{f(MHz)}$ feet.

*) length of director = $\frac{455}{f(MHz)}$ feet.

11)

*) driven element = $\frac{455}{180}$

= 2.527 feet

*) Reflector = $\frac{500}{180}$ feet

= 2.777 feet

*) director = $\frac{455}{180}$

= 2.527 feet

9. The beam solid angle of an antenna extends blw $\frac{\pi}{6} \leq \theta \leq \pi$ and $\frac{\pi}{4} \leq \phi \leq \frac{\pi}{3}$. Find the equivalent beam solid angle and maximum directivity in dB.

SOV)

$$\Omega_A = \int_{\frac{\pi}{4}}^{\pi/3} d\phi \int_{\frac{\pi}{6}}^{\pi} \sin\theta \, d\theta$$

$$= [\phi]_{\frac{\pi}{4}}^{\pi/3} \; [-\cos\theta]_{\pi/6}^{\pi}$$

$$= \left[\frac{\pi}{3} - \frac{\pi}{4}\right] \left[-\cos(\pi) + \cos(\pi/6)\right]$$

$$\Omega_A = \frac{\pi}{12} \times 1.866$$

$$\boxed{\Omega_A = 0.4885}$$

$$\Omega_A = 0.4885 \times \left(\frac{180}{\pi}\right)^2$$

$$\boxed{\Omega_A = 1603.8158}$$

WKT

$$D_{max} = \frac{4\pi}{\Omega_A}$$

$$= \frac{4\pi}{0.4885}$$

$$\boxed{D_{max} = 25.724}$$

$$D(dB) = 10 \log (D_{max})$$

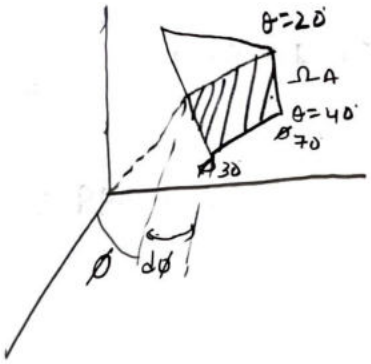
$$= 10 \log (25.724)$$

$$\boxed{D = 14.10 \text{ dB}}$$

Find the number of steradian and square degress on a spherical surface that is b/w $\theta = 20^\circ$, $\theta = 40^\circ$ & $\phi = 30^\circ$ and $\phi = 70^\circ$

(5M)

$$\Omega_A = \int_{30^\circ}^{70^\circ} \int_{20^\circ}^{40^\circ} \sin\theta \, d\theta \, d\phi$$



$$= [\phi]_{30^\circ}^{70^\circ} \; [-\cos\theta]_{20^\circ}^{40^\circ}$$

$$= [70^\circ - 30^\circ] \; [\cos(40^\circ) - \cos(20^\circ)]$$

$$= [40^\circ] \; [0.1736]$$

$$= 40^\circ \times \frac{2\pi}{360} \times 0.1736$$

$\because \; 1^\circ = \frac{2\pi}{360}$

$$\Omega_A = 0.1211 \text{ sr}$$

6. The Friis Transmission eq is used to calculate the power recived from one antenna when transmitted to another antenna separated by some distance. Suppose you have been asked to design an antenna operating at 1GHz with a gain of 25 dB.

What power should be supplied to the transmitting antenna such that is minimum power delivered to the recieving antenna is 10.8 mW The transmitting & receiving antenna are 1km part. The gain of the receiving antenna is 20 dB.

(5M)

$P_t = ?$ $\quad f = 1$ GHz $\quad G_t = 25$ dB $\quad P_r = 10.8$ mW

$d = 1$ km $\quad G_r = 20$ dB

$$P_r = P_t \cdot G_t \cdot G_r \left(\frac{c}{4\pi R f}\right)^2$$

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$$\Rightarrow \quad 10.8 \times 10^{-3} = P_t \times 316.227 \times 100 \times \left(\frac{3\times10^8}{4\pi \times 1000 \times 1\times10^9}\right)^2$$

$$\Rightarrow 10.8\times 10^{-3} = P_t \times 1.8022 \times 10^{-5}$$

$$\boxed{P_t = 599.267 \text{ W}}$$

$G_{t(dB)} = 25\text{dB}$

$25 = 10 \log(G_t)$

$$\boxed{G_t = 316.227}$$

$G_{R(dB)} = 20\text{dB}$

$20 = 10 \log(G_R)$

$$\boxed{G_R = 100}$$

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